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# Mineral Land Classification of the Greater Los Angeles Area

**PART III**

**CLASSIFICATION OF SAND AND GRAVEL RESOURCE AREAS, ORANGE COUNTY-TEMESCAL VALLEY PRODUCTION-CONSUMPTION REGION**

1981

CALIFORNIA DIVISION OF MINES AND GEOLOGY

SPECIAL REPORT 143

PART III

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SPECIAL REPORT 143

# Mineral Land Classification of the Greater Los Angeles Area

## PART III
## CLASSIFICATION OF SAND AND GRAVEL RESOURCE AREAS, ORANGE COUNTY-TEMESCAL VALLEY PRODUCTION-CONSUMPTION REGION

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1981

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# FORWARD

## By James F. Davis

This report, "Classification of Sand and Gravel Resource Areas—Orange County-Temescal Valley Production Consumption Region," is submitted as the second analysis by the California Division of Mines and Geology (CDMG) to the State Mining and Geology Board for transmittal to the local governments which regulate land use in this region. The report has been developed under the Surface Mining and Reclamation Act of 1975, which was enacted by the State Legislature to assure adequate mined land reclamation and mineral resource conservation under the auspices of the Mining and Geology Board and CDMG.

The Mining and Geology Board enacted Guidelines in June 1978 to be employed by the CDMG in its mineral resource classification. This report embodies the intent of those directives. The undertaking is of signal importance in economic geology, because it deals with very specific mineral resource conservation issues in an area of intensive land use.

# PREFACE

The Las Angeles metrapolitan area, with o papulatian of nearly 10 millian peaple, is the largest urbanized area in Califarnio. This regian includes the sauthern part of Las Angeles County ond ports af San Bernardina, Riverside, and Orange caunties. Althaugh substantiol ports of the Las Angeles area hove been developed, wide-spread urbanizatian is still accurring at a rapid rate.

In ony metropoliton or rural region undergoing urbon development, it is af cansiderable impartance that odequate supplies af minerol commadities be readily avoiloble. Minerals used in construction, particularly sand, gravel, ar stane used in cancrete, must be available fram the regian in sufficient quantities and at reasanable costs. Far many years, the Los Angeles area has been fartunate in this respect: odequote quantities af law-cost aggregate materiols, chiefly sand ond grovel, have been available locally. Hawever, as mare and mare lond in o regian becames urbanized, nearby sand and gravel deposits suitable as saurces af law-cast oggregate tend ta be either depleted by mining ar last ta campeting land uses.

The principal abjective af this project is to classify land in the Los Angeles areo into Mineral Resaurce Zanes based an guidelines adapted by the Califarnia State Mining and Gealagy Board. This classificatian is mandated by the Surface Mining ond Reclamatian Act of 1975. The purpose of the classification is ta assist the State Mining and Geclagy Board in designating lands that are needed by the regian for their mineral cantent.

Classificatian infarmatian will be submitted ta the State Mining and Gealagy Baord in six parts, ane far each af the six praductian-cansumptian regians that have been identified in the greater Los Angeles metrapalitan area. An intraductary sectian describing the background, purpose, ond scope of the overoll praject and ane sectian an the classificotion of each of the six praductian-cansumptian regions ore being published as they ore completed as parts af Califarnia Divisian af Mines and Gealagy Speciol Report 143. Eoch af the six parts classifying productian-cansumptian regians will include maps shawing the locations of significant sand and gravel deposits and on explonatary text with tables and charts that present dota on papulatian, praduction, oggregote consumptian, future requirements, and estimates of aggregate resaurces.

Port I, the introductory sectian, and Part II, which explains the classificotian af sand and gravel resaurce areas in the Son Fernanda Valley Praductian-Cansumptian Region, were published in a single volume. Part I is alsa being published as a separote valume. The present valume, which focuses an the clossificotian af sand ond gravel resaurce areas in the Orange Caunty - Temescal Valley Praduction-Consumption Region, is Port III af Special Repart 143.

The reader may wish to refer to "Aggregates in the Greater Los Angeles Area," Califarnio Divisian of Mines ond Gealagy Special Report 139, which describes and evaluates the significonce, uses, prices, marketing, transpartation, supply, and ather factars thot relate ta the aggregate industry af the greater Los Angeles metropoliton area.

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# EXECUTIVE SUMMARY

Bosed upon the projected papulotian increose ond the predicted per copito consumption rotes, appraximotely 840 million tans of oggregote will be required ta sotisfy demond in the Oronge Caunty-Temescol Volley Praduction-Consumptian Region to the yeor 2030. In the event of mossive recanstructian fallawing o disoster, this totol could double to 1,680 millian tons (see Figure 3.14). Of these projected omounts, abaut half of the moteriol must meet the requirements of Portlond cement cancrete aggregote.

Current *reserves* (aggregote moteriols believed to be acceptoble far cammerciol use thot exist within praperty awned or leosed by an aggregote producing compony ond far which permission ollawing extractian and processing has been gronted by the proper authorities) totol appraximately 257 millian tans, af which on estimated 182 millian tons ore suitable for use in Portlond cement cancrete. Bosed upan present rotes of praductian, these reserves will be depleted in o little more thon twa decades. The highest predicted demand far constructian materiol in the next 50 years will be in the sauthern Orange Caunty oreo. This oreo is nat anly the farthest from the production districts of the adjacent P-C regian, but is olso o significont distonce fram the Mayhew-Coldwoter fon, which includes 66 percent of the available reserves within the Oronge Caunty-Temescol Valley Praduction-Consumption Region.

*Non-permitted resources* (potentially usoble oggregote materials that may be mined in the future but for which na use permit ollowing extroction hos been gronted, or for which development hos nat been definitely established to be feasible bosed upan current technalagy ar ecanomic canditians) tatol appraximotely 1,200 million tons. It will be necessory to bring into production olmost holf of these nan-permitted resources to meet the predicted need for the next 50 yeors, unless olternotive saurces are relied upon (see Figure 3.14).

The olternotive sources, in order af their estimated feasibility, ore: 1) oggregote producers in the adjocent praduction-consumptian regians; 2) alluvial deposits presently unovoiloble becouse of ordinonces; 3) sedimentory bedrack depasits; 4) saurces for crushed rock; and 5) offshare sediments.

1. Although o significant percentage af aggregote is now shipped inta the Oronge County-Temescol Valley Productian-Consumptian Region fram adjacent regians, the donger of relying an imported oggregote ta caver the gap between supply and demond is thot the odjocent praduction-consumption regions (except far the Son Bernordina Praduction-Consumptian Region) ore olso focing reserve-supply short falls aver the next 50 years; the San Bernordino Praduction-Consumption Regian has about o 65-year supply of reserves. The enormous non-permitted resources af almast 20 billian tons in these odjocent praductian-consumption regions represent o long term, but expensive, olternotive solution.

2. The use of the oggregote in Orange Caunty underlying Caspers Regianal Park ond the sond beneath Feotherly Park ond partians of the Greenriver Galfcourse wauld require mojor land-use changes, but do represent patentiol sources af oggregate af moderately well-known quontity and quolity.

3. The sedimentory bedrack depasits ore nat neorly as well ossessed os are the modern olluviol depasits. Much testing ond evoluotian will need ta be done to discover aggregote depasits of marketoble quolity ond quantity in the bedrack.

4. There ore large quontities af bedrock availoble far crushing ond pracessing os oggregote in ond neor the Oronge County-Temescol Volley Praduction-Cansumption Region. Mast of these rocks ore either within the Cleveland Natianol Farest in Oronge County ar in the area bordering Temescal Wosh in Riverside Caunty.

5. The development af the sond and grovel depasits offshore present o totolly different set of problems. Even if the feosibility of mining these deposits were praven, there would prabobly be o protrocted periad of development necessory for whot oppeors ta be o limited supply.

Twenty-two aggregate resaurce sectars have been delineated in the Orange County-Temescal Valley Praductian-Consumptian Regian based an lithalagic cantinuity and geagraphic separatian. These 22 resaurce sectars are listed on Table 3.6 in arder of their importance ta the Orange Caunty-Temescal Valley Praductian-Cansumptian Regian as determined by the amaunt of aggregate resaurce cantained within each sector and the ease with which that resaurce can be made available ta the market.

An important factar in determining which resaurce sectars in the Orange County-Temescal Valley P-C Regian will be needed to meet the regian's aggregate requirements ta the year 2030 is the percentage af the region's resaurces that will be needed to satisfy thase requirements. Ta calculate this percentage, it is necessary to know nat only

1) the tatal amaunt af aggregate needed ta satisfy the regian's 50-year requirements (approximately 840 millian tans) and

2) the amaunt of resources (reserves: approximately 257 millian tons; nan-permitted resaurces: appraximately 1,200 millian tans) within the P-C regian,

but alsa

3) the amaunt af the nan-permitted resaurces that, practically speaking, can be expected ta be braught eventually ta the aggregate market (that is, canverted ta reserves) and

4) the amount af aggregate that will be imparted fram adjacent P-C regians.

Althaugh these last twa factars are unknawns, by assuming figures far them, we can madel different hypathetical situatians and thereby gain same sense af haw much af the regian's aggregate resaurces may be needed ta satisfy its 50-year aggregate requirements.

*Hypothetical Situation A.* If 60 percent of the nan-permitted resaurces are canverted ta reserves and na aggregate is imported fram adjacent P-C regians, 84 percent of the resaurces within the Orange Caunty-Temescal Valley P-C Regian wauld be required ta meet the prajected 50-year demand.

*Hypothetical Situation B.* If aggregate imparts fram adjacent P-C regians remain canstant at the 1978 level, 70 percent af the resaurces within the Orange Caunty-Temescal Valley P-C Regian wauld be required ta meet the prajected 50-year demand.

*Hypothetical Situation C.* If the present level af aggregate praductian within the P-C regian is held constant and the rate af aggregate imparts fram adjacent P-C regians is increased ta keep pace with demand, 27 percent af the resaurces within the Orange County-Temescal Valley P-C Regian would be required to meet the prajected 50-year demand.

# CLASSIFICATION OF SAND AND GRAVEL RESOURCE AREAS, ORANGE COUNTY-TEMESCAL VALLEY PRODUCTION-CONSUMPTION REGION

## INTRODUCTION

Land in the Orange County-Temescal Valley Production Consumption (P-C) Region of the greater Los Angeles metropolitan area (Plate 1.2, Part I, and Figure 3.1) has been classified by the California Division of Mines and Geology (CDMG) according to the presence or absence of significant aggregate resources. Other mineral resources will be considered collectively in a later project. The land classification for construction aggregate only is presented in the form of Mineral Resource Zones (MRZ's; see Part I) on 27 U.S. Geological Survey topographic quadrangle base maps which accompany this report (Plates 3.7 - 3.33). Refer to Figure 3.2 herein and Figure 1.3, Part I, for an index to quadrangle maps covering the Orange County-Temescal Valley P-C Region. A list of lead agencies located within the Orange County-Temescal Valley P-C Region is presented on Table 3.1.

## ESTABLISHMENT OF MINERAL RESOURCE ZONES

Mineral Resource Zones within the Orange County-Temescal Valley P-C Region are established on the basis of an aggregate resource appraisal which includes: a study of pertinent geologic reports and maps; field investigations; visits to active sand and gravel mining operations; analysis of drill hole data collected from the past 75 years; and inspection of aerial photographs and private company documents. The results of the classification are presented on Plates 3.7 - 3.33. A generalization of the results of classification is shown on Plate 3.1.

### Areas Classified MRZ-1

Several areas located within the western part of the Orange County-Temescal Valley P-C Region have been classified MRZ-1. These are areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence ("Guidelines for Classification and Designation of Mineral Lands," Appendix A-3, Part I). These areas occur in the distal portions of the Santa Ana river flood plain, in the Tustin plain, and in many bedrock areas underlain by fine-grained sedimentary formations. Drill hole data in the flood plain MRZ-1 areas indicate that they are underlain by sedimentary deposits composed predominately of fine-grained material unsuitable for use as aggregate.

*Table 3.1 List of lead agencies (county and incorporated city governments) located within the Orange County-Temescal Valley P-C Region. Cities that have active aggregate operations within their jurisdictions are denoted by asterisks. Lead agencies that have land within their jurisdiction, classified MRZ-2, are denoted by #.*

*# ORANGE COUNTY*

* #Anaheim
Brea
Buena Park
Costa Mesa
Cypress
Fountain Valley
Fullerton
Garden Grove
#Huntington Beach
Irvine
Laguna Beach
La Habra
La Palma
Los Alamitos
Newport Beach
* #Orange
Placentia
San Clemente
* #San Juan Capistrano
Santa Ana
Seal Beach
Stanton
Tustin
* #Villa Park
Westminster

*LOS ANGELES COUNTY*

Artesia
Bellflower
Cerritos
Downey
Hawaiian Gardens
Lakewood
La Mirada
Long Beach
Norwalk
Santa Fe Springs
Whittier

*RIVERSIDE COUNTY*

Corona
Norco
Riverside

*SAN BERNARDINO COUNTY*

Chino

### Areas Classified MRZ-2

Nine areas within the Orange County-Temescal Valley P-C Region have been classified MRZ-2. These are areas where adequate information indicates that significant mineral deposits are

Figure 3.1 Map of the Orange County-Temescal Valley P-C Region.

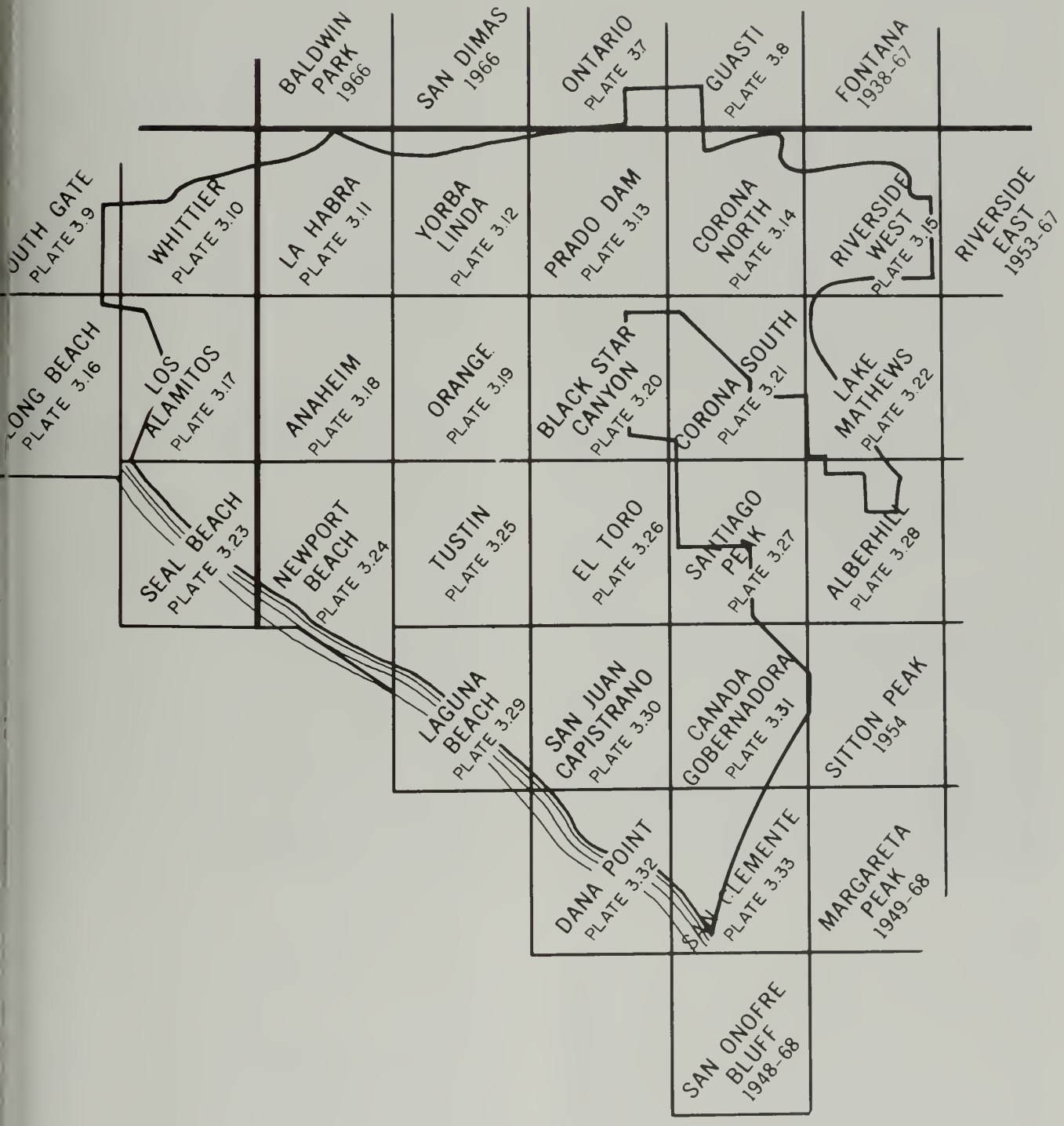



Figure 3.2 Index map of U.S. Gealagical Survey 7½ minute quadrangles (Plates 3.7 - 3.33) covering the Orange County-Temescal Valley P-C Regian.

present or where it is judged that a high likelihood for their presence exists("Guidelines for Classification and Designation of Mineral Lands,"Appendix A-3, Part I).

Several basic geologic conditions control the distribution of aggregate resources in the Orange County-Temescal Valley P-C Region. Recent river and stream deposits, alluvial fans, and bedrock sedimentary formations are the major sources of aggregate. The first major source of sand and gravel consists of river-laid deposits of Holocene age in the Santa Ana River, Santiago Creek, Temescal Wash, Arroyo Trabuco, and San Juan Creek. Coarse material transported from mountain areas has been deposited in river channel and flood plain environments. Such material is often readily accessible and, in many cases, replenishable. Dams built to control the flow of the Santa Ana River and Santiago Creek have, however, precluded the replenishment of the sand and gravel in those stream beds.

Mayhew and Coldwater canyons have debouched alluvium from the eastern flank of the Santa Ana Mountains out onto the floor of the Temescal Valley in western-most Riverside County, during Pleistocene and Holocene times, forming a large coalescing fan. This fan is the second major source of aggregate in the P-C region.

The third major source of aggregate consists of older bedrock deposits that have no potential for replenishment, because the geologic conditions responsible for their origin no longer exist. These are coarse sedimentary deposits which range in age from the Oligocene Sespe Formation to the late Pleistocene marine terrace deposits on Huntington Beach Mesa.

For a deposit of aggregate material to be categorized as significant, it must satisfy the criteria given in the "Guidelines for Classification and Designation of Mineral Lands" (Appendix A-3, Part I). In addition, the geologic factors that resulted in the formation of the deposit must be understood clearly enough so that reasonable subsurface interpretation can be made from surface exposure of the material and from drill hole data.

The deposits within the Orange County-Temescal Valley P-C Region that satisfy these criteria are in the Santa Ana River channel and proximal portions of its flood plain, conglomerate lenses in the Sespe Formation south of Santa Ana Canyon, a coarse-grained facies of the Sycamore Canyon member of the Puente Formation near Prado Dam, the Santiago Creek channel and the proximal part of its flood plain, the channel of Temescal Wash, the Mayhew Canyon and Coldwater Canyon coalescing alluvial fans in Temescal Valley, the San Juan Creek and Arroyo Trabuco channels, and the Huntington Beach mesa.

### *SANTA ANA RIVER*

The Santa Ana River carries alluvial material derived from a large drainage basin which encompasses parts of the San Gabriel and San Bernardino Mountains and the hills north and east of Lake Elsinore, extending as far east as the San Jacinto Mountains. Much of this material has been deposited in the Chino Basin; the remainder of this material has been funneled through Santa Ana Canyon and deposited in the Orange County Basin area and the sea beyond. Prado Dam now prevents alluvium from being transported through the Santa Ana Canyon. The coarser alluvial material that lies in Santa Ana Canyon and within a few miles of its mouth forms a sand and gravel deposit of economic significance (Plate 3.2).

For several decades, beginning in the 1920s, alluvium was mined in and along the Santa Ana River channel near the mouth of the canyon and a few places farther out on the flood plain. The largest operations have been centered near the end of Burruel Ridge near the town of Olive. Except for the R. J. Noble Co pany pit, all of the operations have primarily produced sand. coarse gravel occurs at depth in most of this area, but it blanketed by a sand layer that ranges from about 25 feet thi near Prado Dam to more than 70 feet thick near the mouth the canyon (Plate 3.3, cross sections B-B' & C-C'). The R. Noble Company extracts aggregate from a deposit at least 1 feet thick, which is made up of approximatley 50 percent coar material. Within the coarse fraction, several varieties of granit rock are represented, followed by subordinate amounts of vc canic rock and sandstone.

### *PUENTE FORMATION, SANTA ANA CANYON*

One half mile west of Prado Dam, the Owl Rock Compar mines aggregate from a coarse-grained section of the Sycamo Canyon Member of the Puente Formation (Plate 3.2). The be there are folded into an east plunging syncline, with dips rangi mostly from 40 degrees to 60 degrees to the south. Near t surface, the deposit is chemically weathered extensively. T gravel content is about 15 percent, with an arkosic sandsto matrix. The conglomerate clasts are mostly granite with less amounts of volcanic rock, quartzite, sandstone and metased ments. The deposit covers about one-half square mile and ma be as much as 1,000 feet thick.

### *SESPE FORMATION, SANTA ANA CANYON*

Conglomerate of the Oligocene Sespe Formation has bee mined by the Owl Rock Company since 1967 at its Star plant i Gypsum Canyon adjacent to the south side of Santa Ana Ca yon, 13 miles east of Anaheim (Plate 3.2). The deposit has bee extensively weathered to a depth of about 100 feet, resulting i development of clay, substantially weakening much of the coars fraction. The material below the zone of alteration is hard an durable. An estimated 60 percent of the deposit is coarse aggr gate, and is composed of granite, volcanic rocks, feldspathi gneisses, and schists. Almost no sand is produced from th deposit. The deposit is about 4,000 feet long and 2,000 feet wid and is at least 400 feet thick. Similar deposits of Sespe Conglom erate are exposed about 4 miles to the southeast in Weir an Blind canyons. Preliminary data indicate that economic quant ties of suitable aggregate material underlie a total area of a littl over two-tenths of a square mile.

### *SANTIAGO CREEK*

Santiago Creek has its headwaters near Saddleback Mountai in the Santa Ana Mountains. It has a 25-mile-long course ex tending generally northwestward to its confluence with the Sant Ana River in the City of Orange. Both the stream channel nea its Silverado Creek juncture and the alluvial fan at the mout have been mined for aggregate for many years (Plates 3.2 an 3.4). The latter area has supplied a large share of Orange Count sand and gravel needs since the 1920s. The alluvial deposit in th upper Santiago Creek area consists of approximately 65 percen coarse aggregate containing about 50 percent metavolcanic rock and about equal amounts of granodiorite, sandstone, and shale The depth to the channel floor is very irregular—ranging fron 15 to 40 feet—but the deposit above the Silverado Creek conflu ence becomes shallower in the upstream direction. The Transi Mixed Company and the Blue Diamond Company are mining aggregate between Irvine Lake and Williams Canyon, a distanc along the creek of 4.8 miles. The deposit underlying Irvine Lak is covered by an unknown thickness of fine sediments. Certainly

me aggregate exists there, having been deposited prior to the m construction. Downstream of Irvine Dam, the stream chan- l is narrow for several thousand feet but probably contains onomic quantities of aggregate. All of the alluvium in the wide ea below Irvine Park, in the vicinity of the Villa Park Dam, is mined some years ago by the Sully-Miller Company (now ue Diamond). This area is shown on Plate 3.2 with a crossed- t, shaded pattern. Downstream of the Villa Park Dam, where e channel turns southwestward onto the flood plain, the depos- thickens considerably. Drill hole data indicates that the aver- e thickness of this alluvial fan may be as much as 540 feet late 3.3, Section A-A'). Recent records of the water table in is area show an average depth to ground water of about 300 t. The demonstrated width of the usable aggregate in this part the fan is limited by the available drill logs but may be more erally extensive than shown on Plate 3.2. Several sand and avel companies have mined in this area in the past; the two maining operators are the Conrock Company and Blue Dia- ond Materials.

### EMESCAL WASH

Temescal Wash drains the northern Temescal Valley, receiv- g drainage from the northeastern Santa Ana Mountains, the avilan Plateau area and overflow from the Lake Elsinore basin late 3.5). However, as Lake Elsinore has acted as a catchment sin for material transported by the San Jacinto River, the uvial deposits in Temescal Wash are derived from the first two urce areas and primarily from the higher Santa Ana Moun- ins. Consequently, the majority of the rock types in the deposit e metasedimentary with some metavolcanic and granitic types d lesser amounts of sandstone. About 55 percent of the depos- are gravel. The quality of the recent alluvium in most of emescal Wash is economic, as evidenced by the sand and gravel ants that have and are now operating along the canyon. At esent, two quarries are in operation—the Corona Rock oducts Company pit and the Fontana Paving pit, both of hich are near the town of Corona. Downstream about 2 miles m the Corona Rock Products pit, the quality decreases as the e-grained fraction increases. This is probably due to a combi- tion of the decrease in load-carrying capacity in this drainage d the influx of debris from the large alluvial fan to the south. e material in this fan is derived from the northeastern Santa na Mountains, and is less sorted and contains significant nounts of silt and clay. The width of the alluvial deposit in emescal Wash ranges from 200 to 1,000 feet along most of its gth and widens to 3,000 feet near Corona. It ranges in thick- ss from about 33 feet in the upper part of the drainage near lberhill to approximately 100 feet near Corona.

### AYHEW-COLDWATER FAN

The Mayhew-Coldwater Fan is on the southwest side of emescal Valley about 7 miles northwest of Lake Elsinore and out 12 miles by highway from Corona (Plate 3.5). The alluvial bris from Coldwater Canyon on the northwest and Mayhew anyon on the southeast forms a coalescing fan along the base the Santa Ana Mountains. The fan material is derived mainly m the granodiorite exposed to the southwest. The gravel frac- n ranges from 65 percent in the Coldwater Fan to about 30 rcent in the Mayhew Fan. The sand fraction is made up mainly coarse-grained quartzo-feldspathic sand with minor amounts silt and clay. The entire fan area covers about 1.1 square miles d is estimated to have a thickness of 600 feet of alluvial materi- . Major production of sand and gravel began here in 1975 and has expanded until, in 1980, nearly the entire fan area was under lease. Four companies are involved, including Chandler's Palos Verdes Sand and Gravel Company, C. L. Pharris Sand and Gravel Company, J.F. & T. Sand, Inc., and Foster Sand and Gravel, Inc.

### SAN JUAN CREEK

The San Juan Creek deposit is located in southeastern Orange County, about 25 miles from Santa Ana (Plate 3.6). It extends along San Juan Creek about 11 miles from the southwest flank of the Santa Ana Mountains to the community of San Juan Capistrano — a few miles from the ocean. Alluvial material in this deposit is Holocene to Pleistocene in age and consists of about 20 percent coarse aggregate composed mostly of metavolcanic rocks with subordinate amounts of granodiorite and lesser quantities of sedimentary rocks derived from the Santa Ana Mountains. The remaining 80 percent of the deposit is mostly sand with some finer material. This stream channel deposit averages about 1,500 feet in width and ranges in thickness from an estimated 30 to 85 feet. The configuration of the stream channel bottom is very irregular, but averages about 75 feet in depth judging from well logs in the area. The Conrock Company has mined aggregate from this source since 1965 in an area about 6 miles east of San Juan Capistrano. The quality of the alluvial material apparently is reduced below its confluence with Arroyo Trabuco, probably by deleterious material carried into it from the Oso Creek drainage.

### ARROYO TRABUCO

The Arroyo Trabuco production area is located about 5 miles north of San Juan Capistrano (Plate 3.6). The alluvial material in Arroyo Trabuco, like that in San Juan Creek to the southeast, is derived from the Santa Ana Mountains. It is comprised of about 50 percent aggregate and 50 percent sand with lesser amounts of silt and clay. The channel of Arroyo Trabuco attains a sufficient size to hold economic quantities of aggregate at a point about 2 miles above Trabuco Oaks. For a distance of about 12.5 miles downstream from that point to its confluence with Oso Creek, the deposit is probably economical in size and quality. The deposit averages about 700 feet in width, ranging from 500 to 1,500 feet; the average thickness, taken from scanty well log information, is about 70 feet. About 3 miles of Arroyo Trabuco northeast of Highway I-5 is under lease by the Livingston-Graham Company, which has been mining the deposit since the early 1920s. The Oso Creek drainage which joins Arroyo Trabuco below this area, brings large amounts of deleterious material into Arroyo Trabuco and renders the deposit less suitable for aggregate use downstream from the juncture.

### HUNTINGTON BEACH MESA

For many years sand has been mined from pits on the northwest part of Huntington Beach Mesa about 8 miles southwest of Santa Ana (Plate 3.1). The Lance Tidwell quarry was in operation there until about 1954; the Bruce Brothers pit was worked until 1972; from the 1950s to 1978, Blue Diamond extracted sand from a pit just north of Ellis Avenue and about 1,000 feet east of Golden West Street. The deposit, the extent of which is very generally known by well logs, consists of flat-lying marine pebbly sandstone of the San Pedro Formation of Pleistocene age. About 10 percent of the material is coarse clasts of granite or

diorite and some gneiss and sandstone; the remainder is a medium- to coarse-grained sand with very little silt or clay. Well logs in the area indicate a thickness of suitable material of 150 feet. This area is now urbanized.

## Areas Classified MRZ-3

A large part of the Orange County-Temescal Valley P-C Region has been classified MRZ-3 (Plate 3.1). Areas classified MRZ-3 are those areas containing mineral deposits (aggregate), the significance of which cannot be evaluated from available data (Appendix A-3, Part I). MRZ-3 areas located in basin or valley regions are generally underlain by Quaternary alluvial deposits containing sand and gravel, but resource evaluations cannot be made because of inadequate subsurface data on quality. MRZ-3 areas located in hilly or mountainous terrane such as the Puente Hills or Santa Ana Mountains are generally underlain by coarse-grained beds of Tertiary or Late Cretaceous sediments of undetermined significance as potential aggregate sources, or by Jurassic or Cretaceous metasedimentary rocks, metavolcanic rocks, or crystalline basement rocks of possible value as crushed aggregate materials (Plate 3.1).

Inadequate data is available to make a more definite classification of such areas to MRZ-1 or MRZ-2; however, a general discussion about some of these deposits is presented below. Those MRZ-3 areas that are most promising as potential sources of aggregate or crushed rock are discussed in the "Alternative Sources of Aggregate" section, beginning on page 15.

### *PUENTE-CHINO HILLS*

Some of the Tertiary sedimentary formations exposed in the Puente-Chino Hills (Plate 3.1) contain conglomerate and sandstone deposits that are potential sources of aggregate. These are in the La Habra and Fernando Formations and the Sycamore Canyon and Soquel Members of the Puente Formation. Although these rock units have not previously been evaluated in detail for use as aggregate material, both the Sycamore Canyon Member of the Puente Formation and the Fernando Formation deserve special note. A section of the Sycamore Canyon Member is presently being mined near Prado Dam in the far southeastern corner of the hills and, as there are other conglomeratic lenses in the Sycamore Canyon Member nearby, it is possible that one or more of them may be economically mined. The Fernando Formation is being mined for base material in a quarry near Carbon Canyon.

### *THE SANTA ANA MOUNTAINS*

The southwest flank of the Santa Ana Mountains is underlain by a thick sequence of Late Cretaceous- through Tertiary-aged sedimentary formations, some of which may have a potential as future sources of aggregate. Detailed geologic mapping in this area done by CDMG personnel in the past has indicated that such possibilities exist for the following units: stream terrace deposits bordering a few of the major drainages, the Niquel Formation, the Oso Member of the Capistrano Formation, the Sycamore and Soquel Members of the Puente Formation, the Topanga, Sespe, Santiago and Silverado Formations, the Schultz Ranch and Starr Members of the Williams Formation, the Baker Conglomerate Member of the Ladd Formation, and the Trabuco Formation. Significant amounts of aggregate have been produced from unclassified areas of the Santa Ana Mountains in the past, and it is likely that it will produce in the future (s "Alternative Sources of Aggregate" section, below).

### *SAN JUAQUIN HILLS*

The San Joaquin Hills lie at the southeast edge of the Oran County Basin. The bedrock units there are essentially of tl same Tertiary-aged section as that which is exposed in the San Ana Mountains foothill area, and they represent potential b untested sources of aggregate.

### *ORANGE COUNTY BASIN ALLUVIAL DEPOSITS*

A large area of the Orange County Basin is underlain l deposits that are, overall, too fine to be classified as a MRZ- But within this area are isolated alluvial deposits coarse enou to be of some potential. Insufficient data are available at prese to define those areas.

### *CHINO BASIN*

The Chino Basin is part of the Santa Ana River floodpla formed upstream of the Santa Ana Canyon. Alluvial deposits sufficient quantity and quality may be found here as suggeste by a number of favorable well logs. However, the low density these data points and the spottiness of those showing possib good deposits make it unreasonable to define any deposits he as significant. Also included in this area are bedrock deposi such as the Rubidoux Hills and the La Sierra Hills, which a composed of igneous rocks. These bedrock areas are potenti sources of decomposed granite or crushed stone, but test data c suitability are lacking.

### *TEMESCAL VALLEY*

All of the geologic units in this area except the alluvium Temescal Wash and in the Mayhew - Coldwater Fan (see "Are Classified MRZ-2" section, above) have an undetermined pote tial as a source of aggregate. The bedrock formations expos along the northeast flank of the Santa Ana Mountains are a reported to contain conglomerate beds. The plutonic and vo canic rocks exposed along the northeast edge of Temescal Valle are potential sources of crushed rock. The large alluvial fa which cover much of the valley floor area are derived from tl Santa Ana Mountains. The quality of aggregate in these fa differ because of the bedrock units exposed in their respecti source areas. The southernmost composite fan included with the P-C region in Temescal Valley, classified herein as MRZ- is derived from the drainages of Coldwater and Mayhew Ca yons. The source area for this fan includes a large area underla by plutonic rocks. Northwest of this area the fans are most derived from source areas underlain by metamorphosed sed mentary and volcanic rocks. These fans are classified MRZ-

## EVALUATION OF AGGREGATE RESOURCES IN ORANGE COUNTY-TEMESCAL VALLEY P-C REGION

An analysis of aggregate supply in the Orange County-Teme cal Valley P-C Region is presented in this section of the repo The analysis was conducted on the basis of a quantitative evalu tion of aggregate resources contained in urbanizing portions the Orange County-Temescal Valley P-C Region. A similar, b

preliminary, evaluation was made of aggregate resources in the adjacent Claremont-Upland and San Bernardino P-C regions (Plate 1.2, Part I) in order to determine what effects these regions might have on the availability of aggregate in the Orange County-Temescal Valley P-C Region (Anderson and others, 1979). These latter evaluations, along with a summarized evaluation of the San Gabriel P-C Region taken from a concurrent study, are presented in the "Alternative Sources of Aggregate" section, beginning on page 15.

The Orange County-Temescal Valley P-C Region contains approximately 1,500 million tons of economically available aggregate resources (see Table 3.3). Of this, about 250 million tons is presently covered by use permits *(reserves)*. It is estimated that 71 percent of the *reserves,* or 180 million tons, and 62 percent of the remaining *resources,* or 740 million tons, are suitable for use as Portland cement concrete aggregate.

Much of the Santa Ana River and lower Santiago Creek areas have been classified MRZ-2 (Plate 3.2). By far, the bulk of the sand and gravel deposits contained within these classified areas occurs beneath already urbanized land. As a practical matter these areas can be considered unavailable because they have already been committed to uses that preclude extraction of aggregate. Although aggregate resource measurements presented in this report are restricted to urbanizing areas not yet developed, it can be conservatively estimated that several hundred million tons of acceptable material lies beneath the urbanized portion of the areas classified MRZ-2.

## Data Base

For any appraisal of a resource to have credibility, it must be based on sound data. If the data base is weak, the resource appraisal must indicate this fact and, conversely, if it's strong this should also be noted. Terminology used to reflect the confidence level of the data base for this project has been adopted from U.S. Geological Survey Bulletin 1450-A (Appendix C, Part I). The terms *measured, indicated* and *inferred,* as used in the discussion which follows, refer to both reserves and resources, as well as hypothetical resources. For this project, *reserves* are materials believed to be acceptable for commercial use that exist within property owned or leased by an aggregate producing company and for which permission allowing extraction and processing has been granted by the proper authorities. *Resources* include reserves and also all potentially usable aggregate materials (non-permitted resources) that may be mined in the future but for which no use permit allowing extraction has been granted, or for which development has not been definitely established to be feasible based upon current technology or economic conditions.

Much of the resource evaluation that follows is based on drill hole records of variable reliability, collected over a time span extending back to the early part of this century. They describe the types of earth materials (silt, sand, gravel, clay, and bedrock types) encountered at various depths. The quality of drill-hole descriptions range from poor to very good, but only drill hole records that contain descriptions judged to be acceptable for analysis were used in this study.

## Constraints on Mining

To calculate the aggregate material remaining either as reserves or non-permitted resources, the regulatory and economic constraints had to be addressed.

In Orange County, two codes set the regulatory standards: they are the Sand, Gravel, and Mineral Extraction Code (Ord. NR. 2653) and the Sand and Gravel (SG Zone) Extraction District Code (Ord. NR 2656). The first is a safety code that deals with the limiting standards of setbacks and slopes. The other areas of regulation that this code covers are not limiting in regard to aggregate extraction. The second code is a zoning ordinance which sets the maximum depth of mining.

Listed, these constraints are:

1. Minimum setbacks from property lines of 50 feet.
2. Maximum slope of 1 ½:1 above the water table and 2 ½:1 below the water table.
3. Maximum depth of extraction of 150 feet.

In Riverside County—the Temescal Valley area—there are no specific codes pertaining to sand and gravel extraction. Excavation limits are set on a site-specific basis. Setbacks range from 250 feet from main highways to 20 feet from property boundaries, and final slopes are generally set at 1:1. There are no limitations on depth.

The economic constraints that were set for this study, in addition to the criteria given in the"Guidelines for Classification and Designation of Mineral Lands" (Appendix A-3, Part I) and those mentioned in Part I,"Per Capita Consumption of Aggregate,"are:

1. Combined silt and clay layers must not exceed 25 percent of drill hole column.
2. Technology limits extraction to a maximum of 100 feet below the water table.
3. For *resource* calculations, quarry sideslopes are limited to 1:1.
4. The deposit must consist of sound, durable material substantially free of chemical reactive substances that would preclude its use as a construction material.

## Resource Sectors

The extractable sand and gravel deposits suitable for aggregate within the urbanizing portions of the Orange County-Temescal Valley P-C Region are considered as 22 internally consistent sectors in seven general resource areas for the purpose of making resource estimates: Sectors A-I, Santa Ana River Resource Area; Sectors J and K, Lower Santiago Creek Resource Area; Sectors L-N, Upper Santiago Creek Resource Area; Sectors O-S, Temescal Wash and Mayhew-Coldwater Fan Resource Areas; Sectors T-V, Arroyo Trabuco and San Juan Creek Resources Areas. The criteria used to delineate the sectors were lithologic continuity and geographic separation. A deposit having no significant changes in aggregate character from one part to another would be demarked as a single sector. One such area is Sector S, the Mayhew-Coldwater fan deposit. Another sector was drawn wherever a change in the lithologic character was noted or expected.

Most of the areas covering the large deposits are broken up by urbanization. Generally, each of the isolated open areas were given separate sector designations, especially if the land-use factors could be expected to differ. Some of the data used in this section was extracted from a previous report by J.R. Evans and others, published in 1979 as Special Report 139, "Aggregates in the Greater Los Angeles Area, California." Further description of the geology of these areas is in the preceding section on areas Classified MRZ-2.

A tabulation of the calculated resources contained in these Resource Areas is given in Table 3.2.

## *SANTA ANA RIVER RESOURCE AREA*

Included within the Santa Ana River resource area are Sectors A through I (Plate 3.2). These sectors cover the unurbanized portions of the Santa Ana River MRZ-2 area and the two bedrock MRZ-2 areas near the Santa Ana River (Sectors H and I).

### *Sector A*

Interpretation of the drill hole records in Sector A indicates a thickness of minable sand and gravel of about 60 feet. Of this, the top 25 feet is primarily sand (see cross section B - B', Plate 3.3). The density of the material is estimated to be .050 tons per cubic foot. A calculated 25.3 million tons of sand and sand and gravel are within Sector A.

The aggregate immediately downstream of Prado Dam may not be feasible to excavate without endangering the safety of the dam.

### *Sector B*

Sector B is the nonurbanized area along the north side of the Santa Ana River near its middle reaches within Santa Ana Canyon. Drill hole logs in this area show a layer of sand and an underlying basal gravel—the Talbert aquifer—with a combined thickness of about 60 feet. A clay layer separates the sand from the basal gravel in some areas (see cross section B - B', Plate 3.3). A resource of 66.7 million tons was calculated for the aggregate in Sector B using a density factor of .050 tons per cubic foot.

Urbanizing pressure is high in this area of Santa Ana Canyon. Both Sectors B and C are adjacent to park land and may be difficult to mine in an acceptable manner.

### *Sector C*

The alluvium in this part of the canyon deepens to about 70 feet, according to drill logs. The resource total of 62 million tons in this Sector includes the basal gravel layer beneath the sand (see cross section B - B', Plate 3.3). The density factor used in calculating the total resources was .050 tons per cubic foot.

### *Sectors D, E, and F*

Sectors D, E, and F are all vacant or agricultural plots isolated within a rapidly industrializing area of Orange County near the mouth of Santa Ana Canyon. Extensive quarrying of sand has taken place in Sector F along the bank of the Santa Ana River. Urbanization is continuing to rapidly reduce the open areas here and will probably divide these sectors further within the next few years.

Drillers' logs in this area show a 65 foot thick sand lay overlying gravel. Mining in these sectors would be limited i ground water. Sector D has a total minable depth of 150 fe Sector E a minable depth of 180 feet; and Sector F could mined to a depth of about 210 feet. All of the calculations we made assuming a density of .050 tons per cubic foot. The low gravels would probably have a higher density but have not be tested; therefore the more conservative density is used. The tot resources in these sectors are: 32 million tons in Sector D, 9 million tons in Sector E, and 58.9 million tons in Sector F.

### *Sector G*

Sector G is owned by the R.J. Noble Company, which mining aggregate here. Drill logs of nearby holes indicate thickness of minable material of about 180 feet with a density .062 tons per cubic foot. Reserve and resource figures for Sect G are confidential.

### *Sector H*

The Owl Rock Company operates its Prado plant in Sector H mining the bedrock Sycamore Member of the Puente Formatic (see "Areas Classified MRZ-2" section, above). Total minab resource depth is limited by side slopes calculated at 1:1. Tl density of the material is .055 tons per cubic foot. The reser and resource totals for Sector H are confidential; the resour total includes aggregate material in right-of-ways for utilities

### *Sector I*

Most of Sector I lies within the lease of the Owl Rock Produc Company Star Operation, which is mining aggregate from th Sespe Formation (see "Areas Classified MRZ-2" sectio above). Geologic maps indicate a total thickness of material at least 400 feet, but available resources are limited by require side slopes of 1 ½:1. The density of the aggregate is .074 tons p cubic foot. Reserve and resource figures are confidential in th sector and are included in the total for the entire productio consumption region.

## *LOWER SANTIAGO CREEK RESOURCES AREA*

This resource area includes Sector J, which covers the prox mal portion of the Santiago Creek flood plain, and Sector K, group of nearby bedrock deposits of Sespe Formation conglom erate (Plate 3.2).

### *Sector J*

As there are two active quarries within Sector J, owned b Conrock and Blue Diamond companies, the reserve figure i lumped with the total reserves of the P-C region. A density o .065 tons per cubic foot was used for the aggregate resourc calculations in this sector. The total resource for this sector i estimated to be 233.6 million tons to a depth of almost 400 feet Approximately 190 million tons of this resource lies below th depth limit allowed by Orange County ordinance (see "Con straints on Mining" section, p. 7 ). Drill logs in this area indi cate an inconsistent economic quality of material below 200 feet The total thickness of 400 feet of economically minable resource in the lower Santiago Creek area is limited by the ground wate table; below that there is a *hypothetical resource* of from 35 t 160 million tons, depending on the depth to bedrock assumed

*Table 3.2 Aggregate Resources* of the Orange County-Temescal Valley P-C Region.*

| Resource Area | Sector | Text References | Million Short Tons |
|---|---|---|---|
| Santa Ana River: | A | (p. 8) | 25.3 |
| | B | (p. 8) | 66.7 |
| | C | (p. 8) | 62.0 |
| | D | (p. 8) | 32.0 |
| | E | (p. 8) | 9.8 |
| | F | (p. 8) | 58.9 |
| | G | (p. 8) | ** |
| | H | (p. 8) | ** |
| | I | (p. 8) | ** |
| | Total: | | 394.7 |
| Lower Santiago Creek: | J | (p. 10) | 233.6 |
| | K | (p. 10) | 30.0 |
| | Total: | | 263.6 |
| Upper Santiago Creek: | L | (p. 10) | 5.1 |
| | M | (p. 10) | 34.1 |
| | N | (p. 10) | 17.0 |
| | Total: | | 56.2 |
| Temescal Wash: | O | (p. 10) | 10.3 |
| | P | (p. 10) | 36.5 |
| | Q | (p. 10) | 49.0 |
| | R | (p. 11) | 47.4 |
| | Total: | | 143.2 |
| Mayhew - Coldwater Fan: | S | (p. 11) | 330.3 |
| | Total: | | 330.3 |
| San Juan Creek | T | (p. 11) | 149.7 |
| | Total: | | 149.7 |
| Arroyo Trabuco: | U | (p. 11) | 101.2 |
| | V | (p. 11) | 29.3 |
| | Total: | | 130.5 |
| | Grand Total: | | 1468.2 |

* includes the categories of measured, indicated, and inferred. (See Part I, Appendix C, for definitions of terms.)

** cannot be shown due to confidentiality of producer data.

*Table 3.3 Projected aggregate consumption to the year 2030 for the Orange County-Temescal Valley, San Gabriel Valley, Claremont-Upland, and San Bernardino P-C regions.*

| YEARS | ORANGE COUNTY-TEMESCAL VALLEY P-C REGION | | SAN GABRIEL VALLEY P-C REGION | | CLAREMONT-UPLAND P-C REGION | | SAN BERNARDINO P-C REGION | |
|---|---|---|---|---|---|---|---|---|
| | decline in per capita consumption as shown on Figure 3.13 | | decline in per capita consumption from Special Report 143, Part IV | | 5 yr. per capita consumption = 43.7 tons/person | | 5 yr. per capita consumption = 34.2 tons/person | |
| | Average Population (Millions) | Aggregate Consumption (Million Tons) | Average Population (Millions) | Aggregate Consumption (Million Tons) | Average Population (Millions) | Aggregate Consumption (Million Tons) | Average Population (Millions) | Aggregate Consumption (Million Tons) |
| 1980-1985 | 2.51 | 71 | 3.68 | 79 | .54 | 24 | .53 | 18 |
| 1985-1990 | 2.78 | 76 | 3.74 | 79 | .57 | 25 | .57 | 20 |
| 1990-1995 | 3.02 | 80 | 3.82 | 79 | .59 | 26 | .60 | 21 |
| 1995-2000 | 3.21 | 83 | 3.87 | 79 | .61 | 27 | .63 | 22 |
| 2000-2005 | 3.38 | 85 | 3.92 | 78 | .63 | 28 | .65 | 22 |
| 2005-2010 | 3.54 | 87 | 3.96 | 78 | .64 | 28 | .67 | 23 |
| 2010-2015 | 3.70 | 89 | 4.01 | 78 | .66 | 29 | .69 | 24 |
| 2015-2020 | 3.85 | 90 | 4.05 | 78 | .67 | 29 | .71 | 24 |
| 2020-2025 | 3.98 | 92 | 4.09 | 78 | .68 | 30 | .72 | 25 |
| 2025-2030 | 4.09 | 93 | 4.13 | 77 | .69 | 30 | .74 | 25 |
| TOTAL: | | 840 * | | 780 * | | 270 * | | 220 * |

*Figure rounded off to the nearest ten million tons.

This hypothetical resource is not included in the resource total of Table 3.2. The maximum resource depth is known only in the northeast part of the Blue Diamond pit and along its eastern edge where bedrock is exposed. The well logs do not clearly show bedrock depths in the more southwesterly part of the area. Cross sections A-A' and C-C' on Plate 3.3 show a conjectural depth of about 540 feet over most of the sector.

### Sector K

Sector K encompasses three areas underlain by Sespe Formation conglomerate in Blind and Weir canyons. The aggregate material is much like that in Sector H and is assumed to have a similar density of .074 tons per cubic foot. It is estimated that there is approximately 30 million tons of aggregate resource in Sector K.

## UPPER SANTIAGO CREEK RESOURCE AREA

This resource area is divided into three sectors (Plate 3.4). Sector L includes the Santiago Creek channel from the eastern boundary of Irvine Park to Santiago Dam; Sector M encompasses Santiago Reservoir; and Sector N extends from Santiago Reservoir to the farthest limits upstream of economically minable quantities of alluvium in the Santiago and Silverado Creek drainages.

### Sector L

It is estimated that there are 5.1 million tons of aggregate resource in Sector L to an assumed alluvial depth of 20 feet and with an estimated density of .062 tons per cubic foot. Extraction of a part of this deposit may be prohibited by concerns for the safety of Santiago Dam. Special problems may have to be dealt with if mining is to be permitted adjacent to Irvine Park.

### Sector M

Sector M includes the alluvium under Santiago Reservoir and immediately upstream of the lake to the Blue Diamond Company lease boundary. It is assumed that good quality material is under the lake based on the known quality of alluvium in operating quarries immediately upstream. However, significant quantities of silt and clay overburden will be present as accumulations in the lake bottom. A thickness of 30 feet of aggregate material is expected in this sector from drill log data in the adjacent Blue Diamond Company lease. A total resource of 34.1 million tons is calculated for Sector M using a density factor of .062 tons per cubic foot.

### Sector N

Blue Diamond Materials and the Transit Mixed Concrete Company both operate aggregate quarries in Sector N. The reserve figure for this sector is confidential. The economically minable aggregate resources in this sector total an estimated 17.0 million tons. Most of the non-permitted aggregate is in a one-mile stretch of Silverado Creek upstream from its confluence with Santiago Creek. No drill hole data is available in Silverado Creek, but a thickness of alluvium of 20 feet is estimated based on the depth of alluvial fill in Santiago Creek. An assumed material density of .062 tons per cubic foot gives a total of 4.6 million tons in this drainage.

## TEMESCAL WASH RESOURCE AREA

The Temescal Wash Resource Area has four sectors within it. The northern part of the wash includes Sectors O, P, and Q and the southern area is covered by Sector R (see Plate 3.5).

### Sector O

The thickness of economically minable alluvial aggregate in Sector O is estimated from nearby drill hole logs to be about 100 feet. The density of this aggregate is assumed to be .063 tons per cubic foot based on densities of the material being mined in the two active pits about two miles upstream. The total resource in Sector O is calculated to be 10.3 million tons.

### Sector P

Sector P is crossed by the Riverside Freeway and a Santa Fe Railway track. Several old aggregate quarries operated in the area immediately south of this sector, but there are no indications of pits ever having been dug within this sector. Drill hole logs record a thickness of good quality material of 100 feet. Using a density factor of .063 tons per cubic foot, the total resource in Sector P is estimated at 36.5 million tons.

### Sector Q

Within Sector Q are the two operating sand and gravel pits in the Corona area—the Corona Rock Products pit and the Fontana Paving Company pit. From drill hole information, the thickness of economically minable alluvium is estimated to average about 50 feet in the upstream narrow part of the wash and about 80 feet in the wider part of the wash near Corona. The total reserve for this sector is confidential. The total resource figure for Sector Q is 49.0 million tons using a density factor of .063 tons per cubic foot.

### Sector R

Sector R includes the upper or southern Temescal Wash along about a five-mile length. Several small gravel pits that have ceased production are present along the northern part of the sector. The C.L. Pharris Sand and Gravel Company holds a lease on much of this sector. The thickness of the alluvium in Temescal Wash is about 33 feet, judging from widespread drill hole data. The material is of marginal quality because of interbedded layers of silt and clay. Adopting the density factor from the adjacent Mayhew-Coldwater Fan area of .065 tons per cubic foot gives a resource total of 47.4 million tons for Sector R.

## MAYHEW-COLDWATER FAN RESOURCE AREA

This resource area is covered by a single resource sector—Sector S (Plate 3.5).

### Sector S

Almost this entire sector is enveloped by active sand and gravel leases. Calculations based on a density factor of .065 tons per cubic foot and pit wall slopes of 1:1 give reserves totalling 168 million tons to a depth of 150 feet. This depth is considered to be the average ground water level in this area. Economic extraction of aggregate can probably be continued to a depth of 100 feet below the water table; adding the deposits between the

leases (pit walls along common boundaries) to this gives a total resource of 330.3 million tons.

A generalized cross section (Plate 3.5, Section D-D'), drawn using the scant data available, suggests that a thickness of as much as 600 feet of sand and gravel may be present in the Mayhew-Coldwater Fan. If so, another 455 million tons of *subeconomic aggregate resource* lies between the depths of 250 and 600 feet. This aggregate is considered subeconomic because of the difficulties attendant to mining at such depths below the water table. Also, the quality of these deep gravels has not been tested, and they may consist, in part, of older weathered alluvium of low durability.

### *SAN JUAN CREEK RESOURCE AREA*

#### *Sector T*

Sector T covers the San Juan Creek channel between the border of urban development of the community of San Juan Capistrano and the south boundary of Caspers Regional Park (Plate 3.6). Included in this area is the active quarry on the Conrock Company lease. The thickness of the alluvium in this segment of San Juan Creek is generally about 85 feet across the entire channel width, with areas near the outside of channel bends as thin as 30 feet. The reserve figure for this sector is confidential. A total resource figure of 149.7 million tons was calculated assuming a flat channel bottom with 1:1 side slopes and an aggregate density of .0625 tons per cubic foot.

### *ARROYO TRABUCO RESOURCE AREA*

The channel area of Arroyo Trabuco from the limit of urban development in the community of San Juan Capistrano upstream to O'Neill Park is designated as Sector U. The undeveloped area upstream of Trabuco Oaks to the Cleveland National Forest boundary is designated as Sector V (Plate 3.6).

#### *Sector U*

Calculations indicate a total of 101.2 million tons of economically minable stream channel aggregate in Sector U to a depth of 65 feet. A large portion of this resource is within the Livingston-Graham Company lease. The reserve figure for this sector is confidential. The thickness of economic aggregate was taken from very sparse drill hole data. The density factor used for Arroyo Trabuco alluvial material was .0575 tons per cubic foot; also, a flat channel bottom with 1:1 side slopes was assumed.

#### *Sector V*

The well data in this sector is sparse and inconsistent, but it is judged that there is aggregate of economic quality to a depth of 65 feet giving a total of 29.3 million tons. The factors used were a density of .0575 tons per cubic feet of material, a flat channel bottom and, side slopes of 1:1.

## ESTIMATED 50-YEAR CONSUMPTION OF AGGREGATE

The total projected consumption of aggregate in the Orange County-Temescal Valley P-C Region for the next 50 years is estimated to be 844 million tons (Table 3.3).

From past consumption patterns, it is expected that approximately one-half of this will be used as Portland cement concrete aggregate with the remaining half used as asphaltic concrete aggregate, base material, and fill.

## Production and Population Records

Aggregate production and population records were compiled for the years 1960-1976 for the Orange County-Temescal Valley P-C Region (Figure 3.3). The points for the graphs were computed by using a three-year moving average. Records for the years prior to 1960 are in most cases incomplete. Aggregate imported from the adjacent San Gabriel and Claremont-Upland P-C regions was added to the Orange County-Temescal Valley P-C Region production total for the years 1974-1978. Production figures include base and fill from major plants, although these commodities are not considered in MRZ classification. Records of aggregate production and population from 1960 to 1976 were also compiled for the adjacent P-C regions (Figures 3.4-3.6). Population projections to the year 2030 are presented on Figure 3.7.

## Per Capita Consumption Rates

The Orange County-Temescal Valley P-C Region had an average per capita consumption rate of about 5.9 tons of aggregate per year between 1960 and 1976 (Figure 3.8). To project their capita consumption rate to the year 2030, a simple statistical model was calculated using per capita consumption data and population density figures for the four large-population P-C regions in the greater Los Angeles area: San Fernando, San Gabriel Valley, Orange County-Temescal Valley, and San Bernardino. Together these four regions total more than 90 percent of the population within the greater Los Angeles P-C regions.

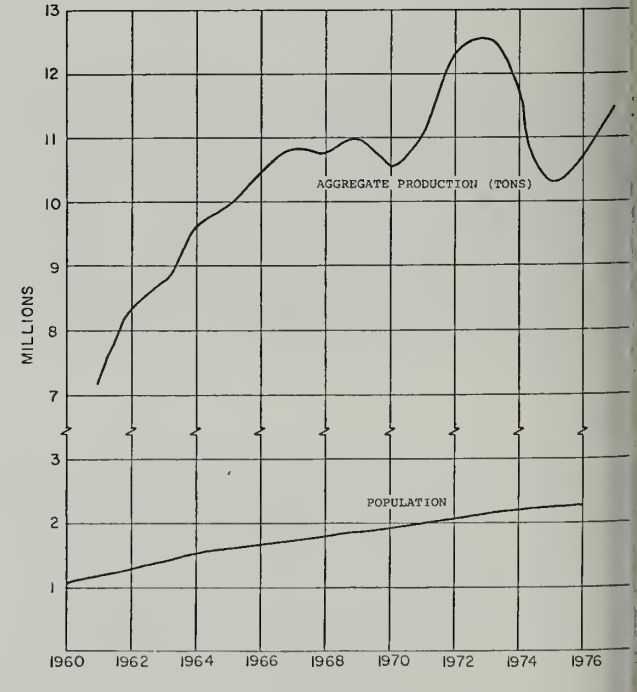
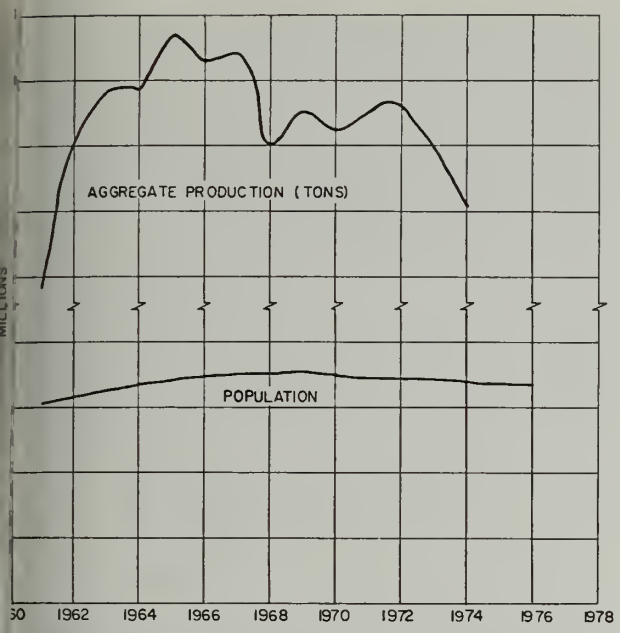
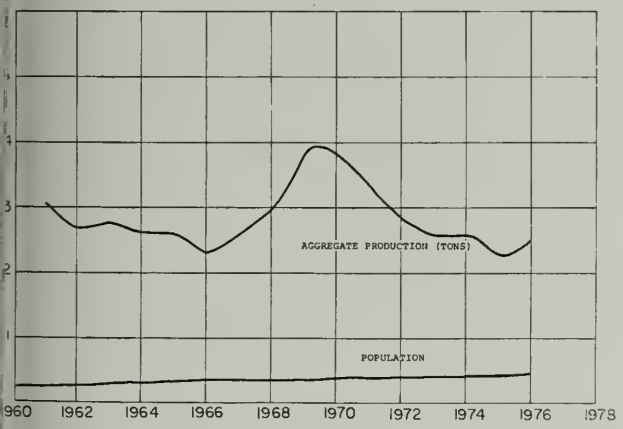


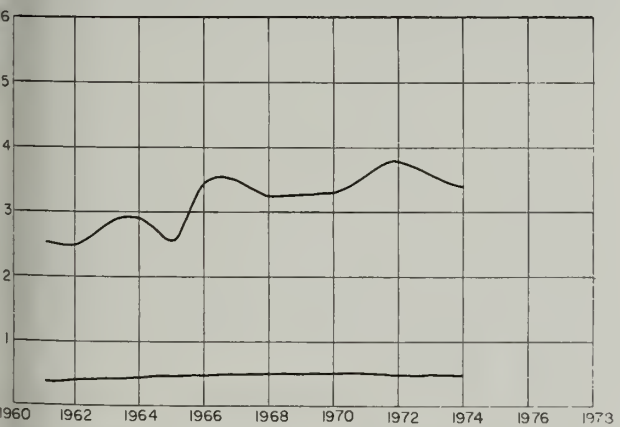

Figure 3.3 Orange County-Temescal Valley P-C Region: population aggregate production record for years 1960-1976.




re 3.4 San Gabriel Valley P-C Regian: papulatian and aggregate praduc- recard far years 1961-1976.




ure 3.5 Claremant-Upland P-C Regian: papulatian and aggregate praduc- recard far years 1960-1976.




ure 3.6 San Bernardina P-C Regian: papulatian and aggregate praductian card far years 1961-1974.

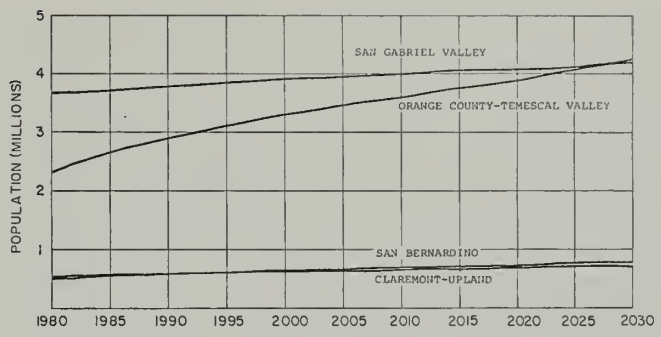



Figure 3.7 Projected papulatian af the Orange Caunty-Temescal Valley, San Gabriel Valley, Claremant-Upland, and San Bernardina P-C Regians ta the year 2030.

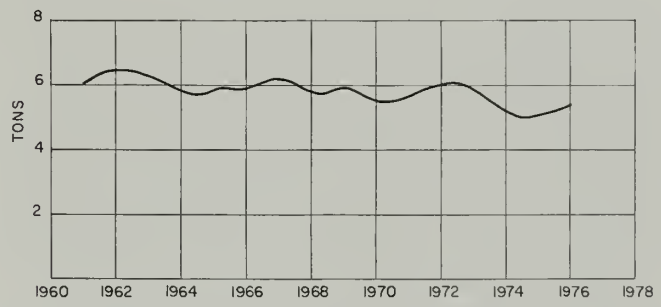



Figure 3.8 Annual per capita cansumptian in the Orange Caunty-Temescal Valley P-C Regian far years 1961-1976.

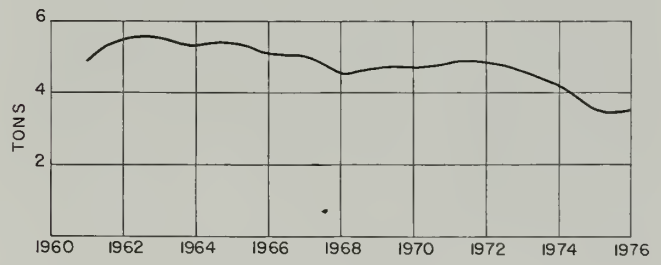



Figure 3.9 Annual per capita cansumptian in the San Gabriel Valley P-C Regian far years 1961-1976.

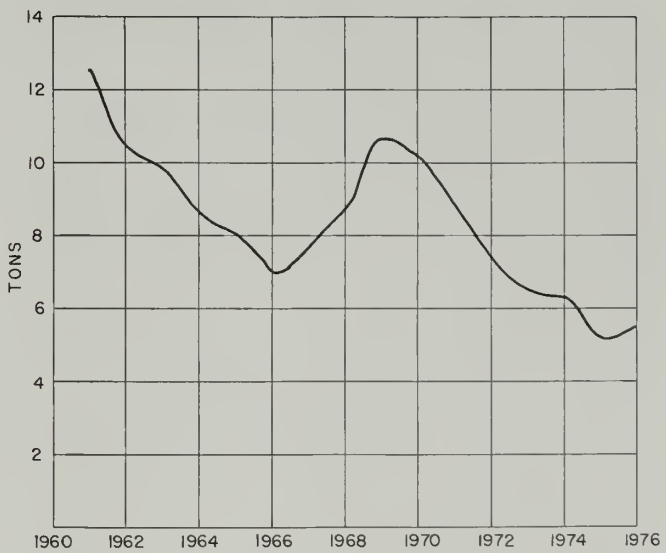



Figure 3.10 Annual per capita cansumptian in the Claremant-Upland P-C Regian far years 1961-1976.

model showed a gradual decline in per capita consumption rate with increased population density. This rate of decline was combined with the population projection for the Orange County-Temescal Valley P-C Region to estimate aggregate consumption needs to the year 2030. The estimate for the San Gabriel Valley P-C region is taken from the San Gabriel Valley P-C Region mineral classification report in progress (Figure 3.9). Similar estimates, without the calculated rate of per capita consumption decline, were made for the Claremont-Upland and San Bernardino P-C regions (Figures 3.10 and 3.11); more thorough analyses of projected per capita consumption rates will be made for the Claremont-Upland and San Bernardino P-C regions when they are studied in detail.

### *POPULATION DENSITIES*

The population density of the Orange County-Temescal Valley P-C Region appears to be moderately low in comparison to the adjacent, more mature, urban area in the San Gabriel Valley P-C Region; the former P-C region is similar in population density to the Claremont-Upland and San Bernardino P-C regions (Figure 3.12). This is reflected somewhat in the average per capita consumption rates established for these areas from 1960 to 1975. The Orange County-Temescal Valley P-C Region has an average per capita consumption rate of 5.9 tons per year compared to a lower rate of 4.5 tons per year for the San Gabriel Valley P-C Region and a slightly higher rate of 6.83 tons per year for the San Bernardino P-C Region. The substantially higher average rate of 8.75 tons per person per year for the Claremont-Upland P-C Region may be due to the lower population in this P-C region, in which case special projects such as freeway construction could cause a large per capita increase. The 50-year population projection for the Orange County-Temescal Valley P-C Region predicts that the level of population density reached will be about 7 people per acre, which is less than that of the present San Gabriel Valley P-C Region, with 10 people per acre. The majority of the population increase is expected to occur in the south Orange County area.

### *FACTORS AFFECTING PER CAPITA CONSUMPTION RATES*

Per capita consumption of aggregate has varied with time and is different in each P-C region (Figures 3.8-3.11). Several factors, such as changes in urban growth, relative degrees of urban maturity, population increase, and major construction projects, can cause variations and differences.

For a large metropolitan area such as the Orange County-Temescal Valley P-C Region, with a population of over 2 million persons, the expected significant factor over the next 50 years is a consistent slow decline in per capita consumption with increasing population density. Figure 3.8 shows a fluctuating but gradually decreasing per capita consumption rate, which may be mainly explained by a decrease in growth rate from about 10 percent per year in the early 1960s to about 2-4 percent in the mid 1970s and partly, on a larger scale, by an increase in population density. The population projection to the year 2030 shows a constant decline in growth rate which, when combined with the projected decline in per capita consumption shown on Figure 3.13, yields a projected aggregate need of 844 million tons for the next 50 years. This projection assumes a level of stability much like that experienced over the last two decades, that is, no war damage, natural disasters, or major economic depressions.

However, such unforeseen events may occur and result in sharp increases or decreases in per capita consumption of aggregate. The amount of aggregate that could be needed in addition to the projected consumption would depend upon the extent d duration of any resultant reconstruction. The average per ca a consumption rate over the next 50-year period in the Ora e County-Temescal Valley P-C Region could increase as muc s 100 percent as a result of massive earthquake damage. Per ca a consumption would probably then gradually return to the l projected for the population density of that time. Similarly, a r a decline due to an economic depression, there would be a gi- ual return to normal projected demands.

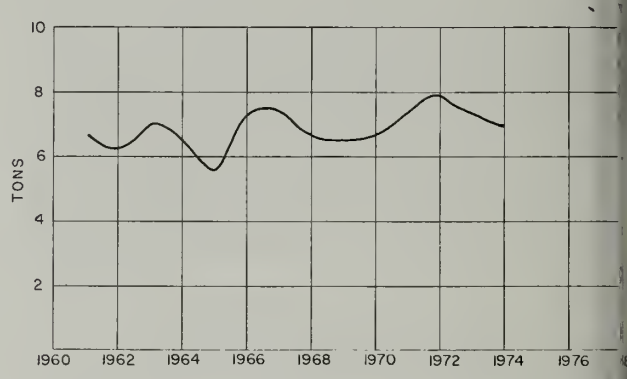



Figure 3.11 Annual per capito consumptian in the San Bernordina P-C Re n far years 1961-1974.

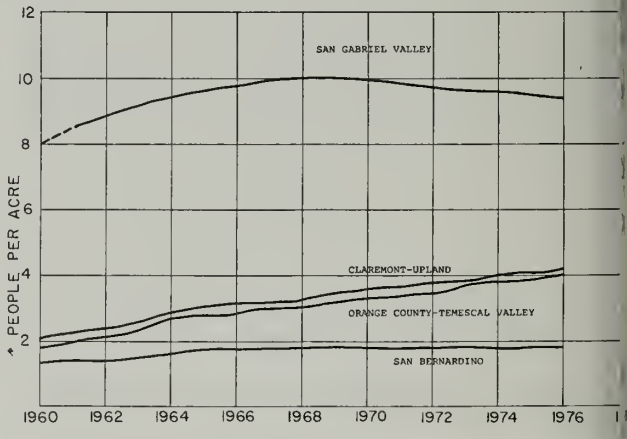



Figure 3.12 Camparison of populotion densities for Oronge County-Teme l Volley, Son Gobriel Volley, Claremant-Upland, and San Bernardina regions far years 1960-1976.

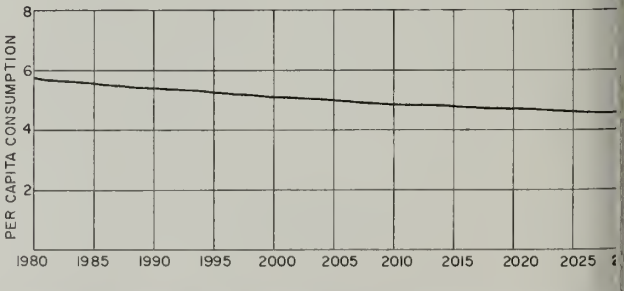



Figure 3.13 Projected per copito consumption for the Oronge County-Ten col Volley P-C Regian ta the year 2030.

## ALTERNATIVE SOURCES OF AGGREGATE

otential sources of aggregate, in addition to the deposits cribed in Sectors A through V, occur in areas within and near Orange County-Temescal Valley P-C Region. These sources ude resources in adjacent P-C regions, Tertiary-aged sedi- itary rocks, crystalline volcanic rocks, Quaternary-aged allu- deposits, and offshore sand and gravel deposits.

xcept for the resources in adjacent P-C regions, too little is wn about the physical and chemical rock qualities (see Part "Overview of Aggregates") of most alternative sources of regate to permit even crude resource estimates. However, a eral discussion about the potential resources, their occur- ce, and factors controlling their utilization is presented in the owing section.

### Sand and Gravel Resources of Adjacent P-C Regions

#### *SOURCE ESTIMATES*

Resource estimates given in this report for the adjacent Clare- nt-Upland and San Bernardino P-C regions represent modifi- ions of data taken from California Division of Mines and ology Special Report 139 (Evans and others, 1979). The *erve* estimate is current to January 1979. The *resource* esti- te was made using published geologic maps with reconnais- ce field checking, including visits to sand and gravel plants erating in 1978. The following parameters were assumed in imating the resource:

(1) Material density ranges from .063 to .065 short tons per cubic foot.

(2) Waste does not exceed 25 percent.

(3) Technology is presently available for economic extraction.

(4) Estimates are limited to areas which are not urbanized and for which mining is still a possible interim land use.

The *reserve* and *resource* figures for the adjacent San Gabriel P-C Region are taken from a study completed concurrently with this study. The estimated resources of the adjacent P-C regions are presented on Table 3.4.

Localities marked as PRZ-2 (Preliminary Resource Zone) on Plate 3.1 contain all of the known tentative MRZ-2 resource areas in the Claremont-Upland and San Bernardino P-C regions. Changes will most likely be made both in the *resource* estimations and the outlines of the zones after a more detailed study is completed.

#### *ESTIMATED 50-YEAR CONSUMPTION OF AGGREGATE IN ADJACENT P-C REGIONS*

Estimated 50-year aggregate needs for adjacent P-C regions are presented on Table 3.3. Comparison of Tables 3.4 and 3.3 shows that the projected 50-year total consumption of aggregate for each of the three adjacent P-C regions is less than their respective total *resource* estimates. However, the total *reserves* in the San Gabriel Valley and Claremont-Upland P-C regions are not sufficient to supply their 50-year projected aggregate needs. If presently non-permitted *resources* within these two P-C regions are not utilized to fulfill future requirements, these P-C regions will be forced to acquire aggregate elsewhere and would cease to be a source for the Orange County area.

In 1978, over 2 million tons or approximately 16 percent of the total consumption of the Orange County-Temescal Valley P-C Region was imported from the adjacent San Gabriel and Claremont-Upland P-C regions. Increased imports from present sources in the three adjacent P-C regions represent the most immediate alternative source of aggregate. The disadvantages of increasing dependency on these outside sources in the future are the greater haulage cost, the added air pollution and fuel consumption attendent to longer haulages, and the lack of control on those sources by the market population of the Orange

*ble 3.4 Aggregate resources of the San Gabriel Valley, Claremont-Upland, and San Bernardino P-C regions.*

| PRODUCTION-CONSUMPTION REGION | INFERRED RESERVES ** (Million Tons) | INFERRED RESOURCES ** (Million Tons) | TOTAL (Million Tons) |
|---|---|---|---|
| San Gabriel Valley | 285 | 3,175 | 3,500 * |
| Claremont-Upland | 44 | 1,334 | 1,400 * |
| San Bernardino | 288 | 14,706 | 15,000 * |
| CATEGORY TOTAL | 600 * | 19,100 * | |
| TOTAL RESERVES-RESOURCES, San Gabriel Valley, Claremont-Upland, and San Bernardino P-C regions: | | | 19,900 * |

Figure rounded off to nearest 100 million tons.
Includes measured, indicated, and inferred categories.

County-Temescal Valley P-C Region. The importance of the last disadvantage will become apparent if *resources* in the San Gabriel Valley and Claremont-Upland P-C regions are not made available in great enough quantity to supply any but their own regional markets. Future aggregate supply from these regions, and perhaps the San Bernardino P-C Region as well, may depend on land-use decisions in which the requirements of the Orange County-Temescal Valley P-C Region may not be taken into account.

## Quarternary Sediments As Alternative

Upstream from Sector T in San Juan Creek, immediately outside the P-C region, is a deposit of aggregate known to be of good quality. The aggregate is in both San Juan Creek and one of its major tributaries, Bell Canyon (Plates 3.31 and 3.1, No. 1). Economic quantities of alluvium fill the drainages for about 3 ½ miles up both canyons from their juncture. At present, the area is included in Caspers Regional Park. As much as 24 million tons of aggregate might be available here as an alternative resource.

In Santa Ana Canyon, a large area now occupied by Featherly Park and Greenriver Golfcourse is classified as MRZ-2 (Plates 3.20, 3.13 and 3.1, No. 2). At some future time the land use of this area may change and open the possibility of sand extraction.

Some of the washes and parts of the large, compound Corona fan to the south of the town of Corona in the Temescal Valley may contain potential aggregate deposits (Plates 3.2 and 3.1, No. 3). Little data is available on the deposits in this area, but from the scattered drill holes and the nature of the bedrock formations in the source areas, it appears likely that the bulk of the aggregate material will have a high silt and clay content. This area is classified as MRZ-3. Sand and gravel was mined from Wardlow Wash for concrete aggregate for Prado Dam construction in 1940 (Gray, 1961, p. 96).

## Tertiary Sedimentary Rocks as Alternative

A large area of the Orange County-Temescal Valley P-C Region is underlain by sedimentary rocks of Tertiary age. Several of these rock formations have been used as aggregate sources in the past, and four of them are presently yielding material. Only two of these, the Sespe Formation in Santa Ana Canyon and the Sycamore Canyon Member of the Puente Formation near Prado Dam, are presently producing aggregate of Portland cement concrete quality. Both of these are classified as MRZ-2 (see "Areas Classified MRZ-2" section). Production from the remaining deposits is used, and has been used, predominantly for base, fill, and asphaltic concrete; the deposits within the urbanizing area are classified as MRZ-3. Although the quality of the material from these sources has not been thoroughly evaluated, production from these deposits commonly does not meet specifications for concrete aggregate. These materials occur as lenses of conglomerate in the Sespe Formation, the Sycamore Canyon Member of the Puente Formation, the Upper Member of the Fernando Formation, and sand in the Oso Member of the Capistrano Formation. In the past, aggregate was also produced from the Soquel Member of the Puente Formation in the unclassified area east of the El Toro Marine Air Station (Plate 3.1, No. 4). These deposits are on private, open-range land.

The Sespe Formation, exposed in areas along the southwestern slope of the Santa Ana Mountains (Plate 3.1, No. 5) and in the San Joaquin Hills (Plate 3.1, No. 6), may have conglomeratic lenses suitable as aggregate sources. Conglomeratic beds other than the one now being mined in the Sycamore Canyon Member of the Puente Formation in the eastern Puente Hills may prove to be alternative sources of aggregate (Plate 3.1, No. 7). The conglomeratic sections of the Upper Fernando Formation exposed along the southern margin of the Puente Hills may provide future sources of aggregate (Plate 3.1, No. 8). The Soquel Member of the Puente Formation in the Round Canyon area in the Santa Ana Mountains contains a few conglomeratic lenses that may be suitable for future economic extraction (Plate 3.1, No. 4). The Oso Member of the Capistrano Formation is a massive sandstone with a very small coarse fraction and yields only sand, which has been used primarily for fill by El Toro Materials Company.

## Cretaceous Sedimentary Rocks As Alternative

The Trabuco Formation of Late Cretaceous age crops out in a long, often narrow, belt from southern Orange County near San Juan Hot Springs to the Santa Ana River, along the southwest flank of the Santa Ana Mountains (Plate 3.1, No. 11). This formation is generally a deeply weathered, reddish, earthy conglomerate. In one area, in upper Williams Canyon, a gray basal member is present. This unit is not as weathered as the rest of the formation, although many of the larger granitic clasts are completely disintegrated. This member thins out both to the north and south.

Two other areas near Williams Canyon are underlain by this gray basal unit; they are parts of blocks that have been displaced to the east by two faults. The total area underlain by the basal member in these three areas is about one-third of a square mile. The Trabuco Formation has never been mined for aggregate. The quantity available will permit economic extraction, but limited testing results indicate that the quality may not permit more than base material as a product. The Trabuco Formation has been classified as MRZ-3 where it is present within the urbanizing area.

## Crushed Rock Sources as Alternative

Volcanic, metamorphic, and plutonic rocks are exposed in the Santa Ana Mountains and in the area west of Corona. Also, some areas along the flanks of the Santa Ana Mountains are underlain by Cretaceous sedimentary rocks that are hard enough to be used as crushed rock. All of these areas that lie within the urbanizing part of the Orange County-Temescal Valley P-C Region are zoned MRZ-3. However, much of the prospective crushed rock resource areas occur outside of the urbanizing area. These also would be classified as MRZ-3, had this information been presented in this report. The higher production and transportation costs for crushed rock as compared to alluvial aggregate are explained in Part I, "Overview of Aggregates."

### *TEMESCAL WASH*

East of the town of Corona, in the area bordering Temescal Wash, are exposed several types of granitic rocks and a volcanic porphyry (Plate 3.1, No. 9). Several quarrying operations in the past have operated in this area for crushed stone. At present, the volcanic porphyry is being mined to provide roofing granules. Limited testing (Gray, 1961) indicates that the granodiorite exposed in this area is suitable for crushed aggregate. The granodiorite on the east side of Temescal Wash near the Corona Rock sand and gravel pit has a well-defined, close joint pattern and would be relatively easy to quarry. The Temescal Wash quartz-latite porphyry is presently being mined for use as roofing

ules; it was quarried for concrete aggregate in the 1930s. The o. potential resource of crushed rock in the Temescal Wash r is many hundreds of million tons.

### NTA ANA MOUNTAINS

he central portion of the Santa Ana Mountains is underlain metasediments, metavolcanics, and granodioritic plutonic cs (Plate 3.1, No. 10). The quartzite beds in the Bedford yon Formation, the metavolcanic rocks in the Santiago Peak canics, and the unweathered portions of the granodiorite are ential crushed aggregate sources, although testing would be essary to delineate suitable areas in this terrane. The com- ly poorly developed jointing in the granodiorite would make rrying difficult in much of the area underlain by this rock- e. The metasediments and metavolcanics should be suitable ause a large percentage of the coarse cobbles in several of the vial resource areas in the Orange County-Temescal Valley Region are derived from these formations in the Santa Ana untains. Also, both of these formations have been quarried rip rap in the San Juan Canyon area for several years (Mor- and others, 1979).

### ETACEOUS SEDIMENTARY ROCKS

he Baker Canyon Member of the Ladd Formation is com- ed of well-indurated conglomerate and sandstone which can broken into blocky fragments by crushing. This member is osed along the western and the northeastern flanks of the ta Ana Mountains (Plate 3.1, No. 11). No tests have been de to determine its suitability as aggregate.

Around the turn of the century, about 200 tons of sandstone m the Baker Canyon Member were quarried as building stone lorton and others, 1979).

## Offshore Sediment Deposits as Alternative

Sand and gravel has been mined successfully for several years m marine sources, notably offshore from the United King- m, Holland, the Virgin Islands, and the Bahama Islands. ere are a few offshore localities adjacent to the Orange County ject area and the nearby islands that contain unassessed osits of aggregate materials. The requirements that would ve to be met in order to mine any of these deposits seem to prohibitive. The environmental problems concerning damage marine life might be some of the most difficult to overcome. wever, because the technology for the extraction of these osits is available, they are considered potential alternative rces of aggregate.

### N PEDRO BAY AREA

Investigators from the Department of Geology of the Univer- of Southern California have identified aggregate deposits shore from San Pedro between Point Fermin and Newport ach (Plate 3.1, No. 12) in water depths ranging from 5 to 15 homs (30-90 feet). Core samples collected from this area monstrate that the sediments are predominantly sand-sized, h only subordinate amounts of pebbles and cobbles. Several llion tons of aggregate are believed to exist offshore from San dro, based on the amount of sampling to date.

### SAN CLEMENTE AREA

A small aggregate deposit is located about 3 miles offshore from San Clemente. Another is about 1 mile offshore from a point 7 miles south of San Clemente. Neither the quantity nor the quality of these deposits have been assessed (Plate 3.1, No. 13).

### OFFSHORE ISLANDS

Several deposits of aggregate are known to occur in the near shore environment at shallow depths adjacent to Santa Catalina, San Clemente, and Santa Barbara Islands. These deposits have not been assessed as to quantity or quality.

## CONCLUSIONS

Based upon the projected population increase and the predicted per capita consumption rates, approximately 840 million tons of aggregate will be required to satisfy demand to the year 2030. In the event of massive reconstruction following a disaster, that total could double to 1,680 million tons (Figure 3.14). Of these projected amounts, about half of the material must meet the requirements of Portland cement concrete aggregate.

Current *reserves* total 257 million tons, of which it is estimated 182 million tons are suitable for use in Portland cement concrete. Based upon present rates of production, these reserves will be depleted in a little more than two decades. This depletion rate may be slowed by increased dependence on imports from adjacent P-C regions. However, the highest predicted demand for construction material in the next 50 years will be in the southern Orange County area. This area is not only the farthest from the production districts of the adjacent P-C regions, but is also a significant distance from the Mayhew-Coldwater fan, which includes 66 percent of the available reserves within the Orange County-Temescal Valley P-C Region.

It is evident that much of the approximately 1,200 million tons of non-permitted aggregate resources in the Orange County-Temescal Valley P-C region should be made available for extraction over the next 50-year period, especially those deposits nearest to southern Orange County (San Juan Creek and Arroyo Trabuco Resource Areas). It will be necessary to bring into production almost half of the Orange County-Temescal Valley P-C Region's *non-permitted resources* measured in this study to meet the predicted need for the next 50 years, unless alternative sources are relied upon (Figure 3.14). However, technologic or economic limitations make it very doubtful that all of these *resources* could be translated into *reserves.* Also, the present land uses of property adjacent to Sectors A, D, E, and F in the Santa Ana River Resource Area make it unlikely that all of these *resources* could be developed. A portion of Sector A is immediately downstream of Prado Dam; Sectors D and E and portions of Sector F are fast-shrinking, isolated islands amid industrial development areas. The use of the inferred *resources* beneath Santiago reservoir in Sector M would present problems to other recreational uses of the lake. It should also be noted that a resource of about 200 million tons in Sector J in Santiago Creek will not be available unless the ordinance in Orange County limiting extraction to 150 feet is changed.

The alternative sources, in order of their estimated feasibility, are: (1) aggregate producers in the adjacent P-C regions; (2) alluvial deposits unavailable because of present land-use; (3) sedimentary bedrock deposits; (4) sources for crushed rock; and (5) offshore sediments.

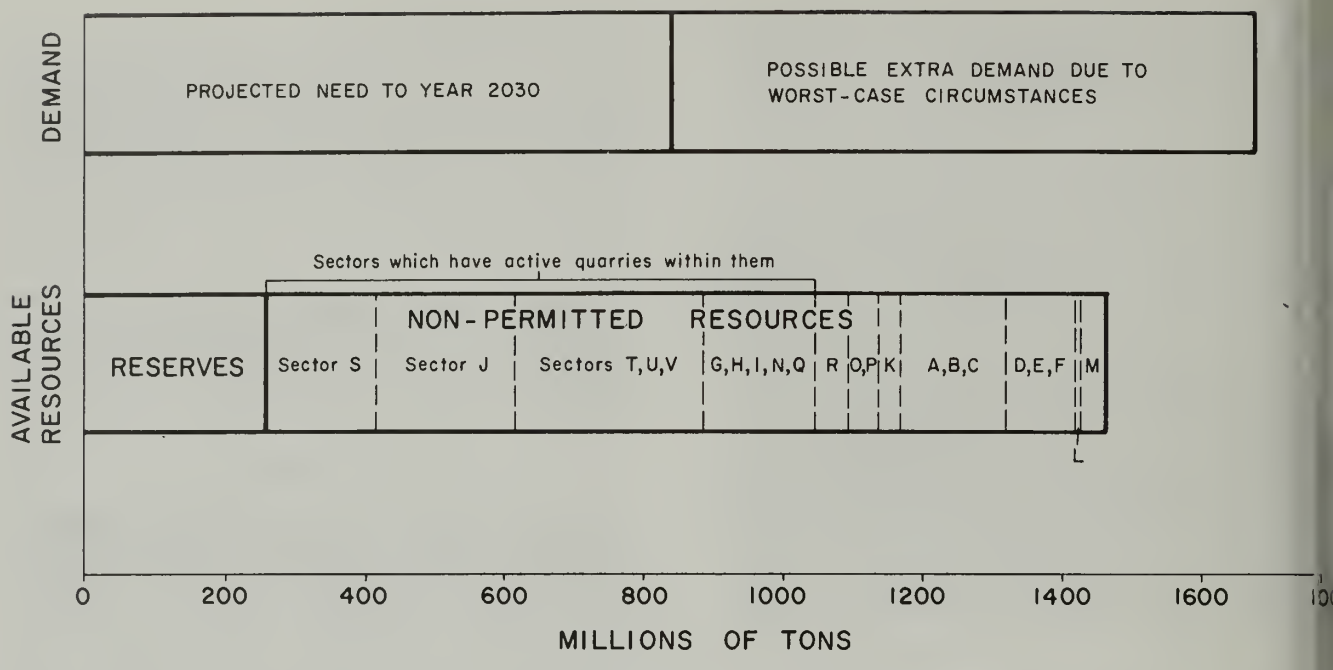



Figure 3.14 Projected demand and available construction aggregate resources in the Orange County-Temescal Valley P-C Region.

Although a significant percentage of aggregate is now shipped into the Orange County-Temescal Valley P-C Region from adjacent regions, the danger of relying on imported aggregate to cover the gap between supply and demand is that, except for San Bernardino, the adjacent P-C regions are also facing reserve-supply short falls over the next 50 years; the San Bernardino P-C Region has about a 65-year *reserve* supply. The enormous non-permitted resources of almost 20 billion tons in these adjacent P-C regions represent a long term, but expensive, alternative solution.

The use of the aggregate in Orange County underlying Caspers Regional Park and the sand beneath Featherly Park and portions of the Greenriver Golfcourse would require major land-use changes, but do represent potential sources of aggregate of moderately well-known quantity and quality.

The sedimentary bedrock deposits are not nearly as well assessed as are the modern alluvial deposits. Much testing and evaluation will need to be done to discover aggregate deposits of marketable quality and quantity in the bedrock.

There are large quantities of bedrock available for crushing and processing as aggregate in and near the Orange County-Temescal Valley P-C Region. Most of these rocks are either within the Cleveland National Forest in Orange County or in the area bordering Temescal Wash in Riverside County.

The development of the sand and gravel deposits offshore presents a totally different set of problems. Even if the feasibility of mining these deposits were proven, there would probably be a protracted period of development necessary for what appears to be a limited supply.

## SUMMARY OF DESIGNATION FACTORS

Table 3.5 shows the 22 aggregate resource sectors in order of their importance to the Orange County-Temescal Valley P-C Region over the next 50 years as determined by the amount of aggregate resource contained within each sector and the ease with which that resource can be made available to the market. The latter depends on such factors as whether or not the resource is already permitted for extraction, its proximity to a market area, and whether or not there are any land-use conflicts with adjoining properties such as dams or parks.

An important factor in determining which resource sectors in the Orange County-Temescal Valley P-C Region will be needed to meet the region's aggregate requirements to the year 2030 is the percentage of the region's resources that will be needed to satisfy those requirements. To calculate this percentage, it is necessary to know not only

1) the total amount of aggregate needed to satisfy the region's 50-year requirements (approximately 840 million tons) and

2) the amount of resources (reserves: approximately 5 million tons; non-permitted resources: approximately 1,200 million tons) within the P-C region,

but also

3) the amount of the non-permitted resources that, practically speaking, can be expected to be brought eventually to the aggregate market (that is, converted to reserves) and

4) the amount of aggregate that will be imported from adjacent P-C regions.

Although these last two factors are unknowns, by assuming figures for them, we can model different hypothetical situations and thereby gain some sense of how much of the region's aggregate resources may be needed to satisfy its 50-year aggregate requirements.

1): Percent of Orange County-Temescal Valley P-C region reserves*
2): Percent of Orange County-Temescal Valley P-C region resources*
3): Percent of Orange County-Temescal Valley P-C region production in 1978
4): Active aggregate mining within this sector
C : Cumulative Percentages

| Sector | Resource Area | % Reserves (1) | C | % Resources (2) | C | % Production (3) | C | Active Mining (4) | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| S | Mayhew-Coldwater Fan | 66% | 66% | 22.5% | 22.5% | 24% | 24% | Yes | Most of sector included within four active aggregate leases. |
| J | Lower Santiago Creek | ** | ** | 16% | 38.5% | ** | ** | Yes | Most of sector lies within two active aggregate leases. Centrally located within market area. Heavy pressure from encroaching urbanization. |
| T,U,V | San Juan Creek and Arroyo Trabuco | ** | 80.6% | 19% | 57.5% | ** | 51% | Yes (T,U) | Only resources located in the fast growing South Orange County area. Much of sector U not under lease including what may be an environmentally sensitive woodland area. |
| G | Santa Ana River | ** | ** | ** | ** | ** | ** | Yes | All of sector within an active lease. Centrally located within market area. Heavy pressure from encroaching urbanization. |
| I | Santa Ana River | ** | ** | ** | ** | ** | ** | Yes | Most of sector within an active lease. |
| H | Santa Ana River | ** | 92.1% | ** | 67.0% | ** | 69.8% | Yes | Most of sector within an active lease. |
| N | Upper Santiago Creek | ** | ** | 1.2% | 68.2% | ** | ** | Yes | Much of sector within two active leases. |
| Q | Temescal Wash | ** | 100% | 3.3% | 71.5% | ** | 93% | Yes | About one-third of sector within two active aggregate leases. Moderately high urbanizing pressure. |
| R | Temescal Wash | — | | 3.2% | 74.7% | — | | No | About one-third of sector within an inactive lease. Quality of aggregate not as high as adjacent Mayhew-Coldwater Fan Resource Area (Sector S). |
| O,P | Temescal Wash | — | | 3.2% | 77.9% | — | | No | Within the town of Corona, high urban pressure. |
| K | Lower Santiago Creek | — | | 2.0% | 79.9% | — | | No | In mountainous terrane close to market area. |
| A,B,C | Santa Ana River | — | | 10.5% | 90.4% | — | | No | Sector B and C are adjacent to a park. Sector A is next to a golf course and immediately downstream of Prado Dam. Urban pressure is high in Sector C. |
| D,E,F | Santa Ana River | — | | 6.9% | 97.3% | — | | No | Sectors D,E and F are in the midst of a rapidly industrializing area. Sector F has two inactive pits within it. |
| L | Upper Santiago Creek | — | | 0.3% | 97.6% | — | | No | Between Irvine Park and Santiago Dam. |
| M | Upper Santiago Creek | — | | 2.3% | 99.9% | — | | No | Area covered by Santiago Reservoir. |

* Includes the categories of measured, indicated, and inferred (See Part I, Appendix C, for definitions of terms.)

** Cannot be shown due to confidentiality of producer data.

*Hypothetical Situation A.* If 60 percent of the non-permitted resources are converted to reserves and no aggregate is imported from adjacent P-C regions, 84 percent of the resources within the Orange County-Temescal Valley P-C Region would be required to meet the projected 50-year demand.

*Hypothetical Situation B.* If aggregate imports from adjacent P-C regions remain constant at the 1978 level, 70 percent of the resources within the Orange County-Temescal Valley P-C Region would be required to meet the projected 50-year demand.

*Hypothetical Situation C.* If the present level of aggregate production within the P-C region is held constant and the rate of aggregate imports from adjacent P-C regions is increased to keep pace with demand, 27 percent of the resources within the Orange County-Temescal Valley P-C Region would be required to meet the projected 50-year demand.

Table 3.5 shows the percentages of reserves and reso represented by the ranked sectors, giving subtotals whe possible with regard to confidential data.

## ACKNOWLEDGMENTS

The California Division of Mines and Geology gratefull knowledges the full cooperation of local government agen organizations, and aggregate producers who provided their v ice during the course of this study. Special thanks are exte to the Southern California Rock Producers Association, Or County Environmental Management Agency, the Southern Ca fornia Association of Governments, and the California Dep ment of Water Resources.

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SPECIAL REPORT 143
PLATE 3.1

# GENERALIZED AGGREGATE RESOURCE CLASSIFICATION MAP

## ORANGE COUNTY - TEMESCAL VALLEY AND ADJACENT PRODUCTION - CONSUMPTION REGIONS

## 1981

By: R.V. Miller, R.E. Corbaley, T.B. Anderson, S.L. Kohler, R.C. Loyd, and M.M. Bushnell

Topographic base by U.S. Geological Survey

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

118°00'

34°00'

MRZ-1 Areas where adequate information indicates that no significant construction aggregate deposits are present, or where it is judged that little likelihood exists for their presence.

MRZ-2 Areas where adequate information indicates that significant construction aggregate deposits are present, or where it is judged that a high likelihood for their presence exists.

MRZ-3 Areas containing construction aggregate deposits, the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information in inadequate for assignment to any other MRZ category.

* PRZ-1 Areas where preliminary information indicates that no significant construction aggregate deposits are present.

* PRZ-2 Areas where preliminary information indicates that significant construction aggregate deposits are present

* PRZ-3 Areas containing construction aggregate deposits, the significance of which cannot be evaluated from preliminary data.

Active construction aggregate producer within the Orange County-Temescal Valley P-C region.

5 General location of possible alternative source of construction aggregate. Number is keyed to text reference - see section ALTERNATIVE SOURCES OF AGGREGATE.

Areas within the production-consumption regions that are not classified.

* These areas will receive more attention at later dates when the production-consumption regions within which they are located are fully studied for construction aggregate resource classification.

PRODUCTION-CONSUMPTION REGIONS

1. ORANGE COUNTY-TEMESCAL VALLEY
2. SAN GABRIEL VALLEY
3. CLAREMONT-UPLAND
4. SAN BERNARDINO

1 RAKO CONSTRUCTION CO. — YORBA LINDA
2 OWL ROCK PRODUCTS CO. PRADO
3 CORONA ROCK - CORONA
FONTANA PAVING, INC. - CORONA
4 OWL ROCK PRODUCTS CO. — STAR
5 R.J. NOBLE CO. ORANGE
6 BLUE DIAMOND MATERIALS — ORANGE
CONROCK CO. — ORANGE
7 BLUE DIAMOND MATERIALS — IRVINE LAKE
8 TRANSIT MIXED CONCRETE CO. — SANTIAGO
9 CHANDLER'S PALOS VERDES SAND AND GRAVEL CO. — GLEN IVY
FOSTER SAND AND GRAVEL, INC. — MAYHEW
J.F. & T. SAND, INC. — COLDWATER CANYON
C.L. PHARRIS SAND AND GRAVEL CO. — MAYHEW
10 EL TORO MATERIALS
11 LIVINGSTON - GRAHAM, INC. — SAN JUAN CAPISTRANO
12 CONROCK CO. — SAN JUAN CAPISTRANO
13 OFFSHORE SAND AND GRAVEL DEPOSITS
14 OFFSHORE SAND AND GRAVEL DEPOSITS

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PLATE 3.2

MINERAL LAND CLASSIFICATION OF THE GREATER LOS ANGELES AREA
ORANGE COUNTY-TEMESCAL VALLEY PRODUCTION-CONSUMPTION REGION

# SANTA ANA RIVER AND LOWER SANTIAGO CREEK RESOURCE AREAS

AGGREGATE RESOURCE SECTORS A-K

By R.V. Miller, R.E. Corboley and T.P. Anderson

1981

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

EXPLANATION

- Drill Hole
- A — A' Geologic Section Line
- Resource Sector
- MRZ-2 Mineral Resource Zone (MRZ) AGGREGATE RESOURCES ONLY
- Operating Aggregate Pit
- Abandoned Aggregate Pit (either backfilled or aggregate completely removed)
- OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
  Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

CALIF. LOCATION

N

BOUNDARY OF AREA SHOWN

LA HABRA · YORBA LINDA · PRADO DAM · ANAHEIM · ORANGE · BLACK STAR CANYON

INDEX MAP TO 7 1/2' QUADRANGLES

Topographic base by U.S. Geological Survey
Reduced from 1:24,000

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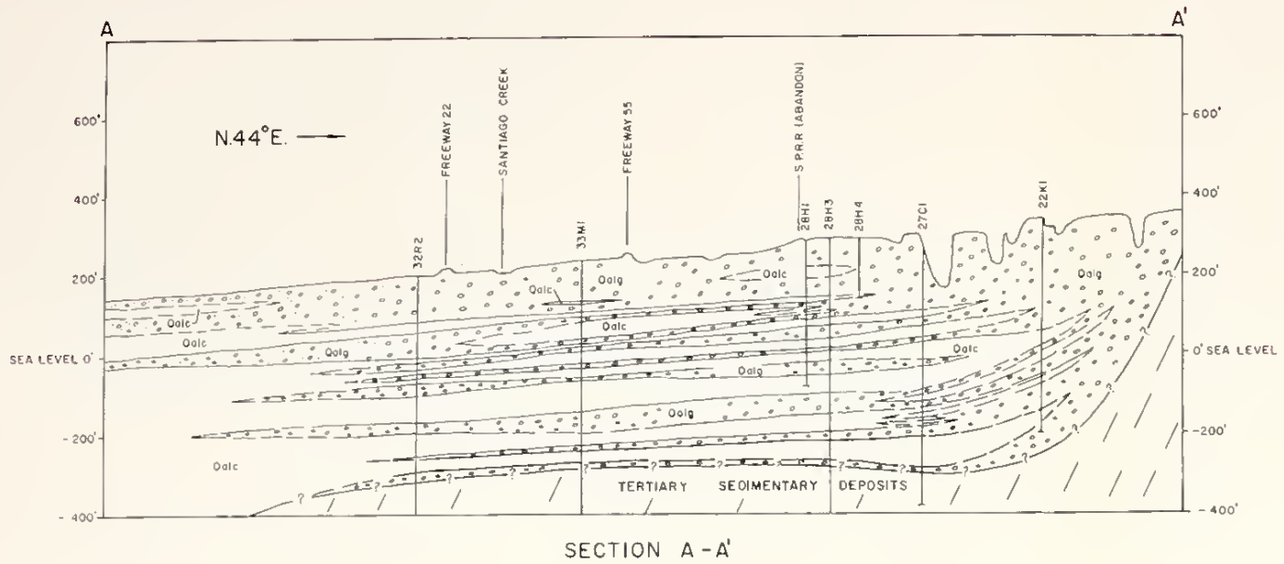
MINERAL RESOURCE LAND CLASSIFICATION OF THE GREATER LOS ANGELES AREA ORANGE COUNTY—TEMESCAL VALLEY PRODUCTION—CONSUMPTION REGION

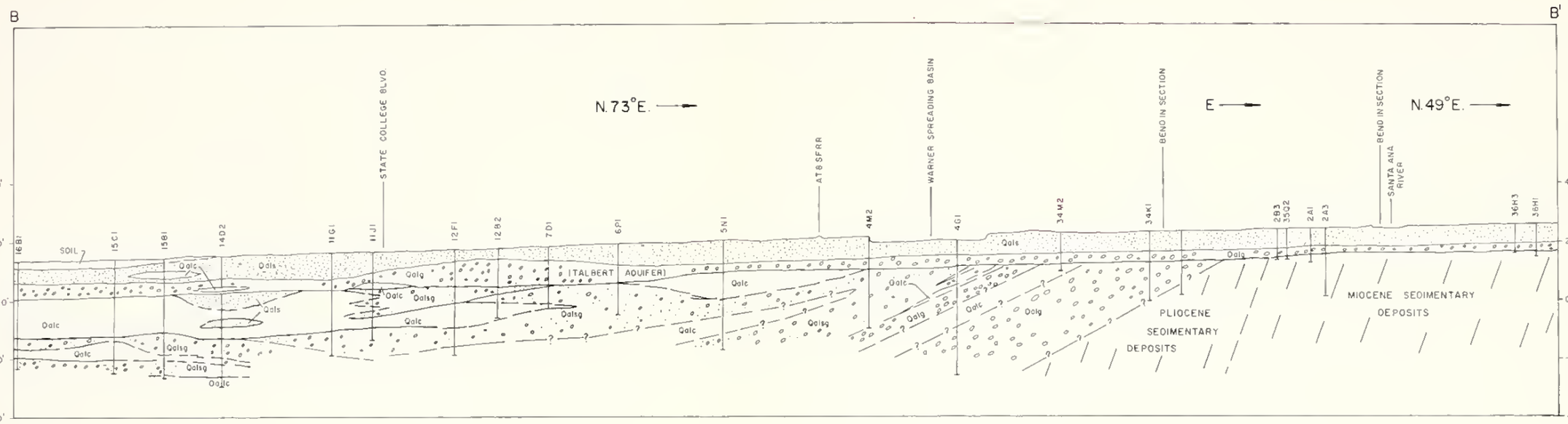
# GENERALIZED GEOLOGIC SECTIONS SHOWING SAND AND GRAVEL DISTRIBUTION, SANTA ANA CANYON AND LOWER SANTIAGO CREEK

By R.V Miller, R. E. Corbaley and T. P. Anderson

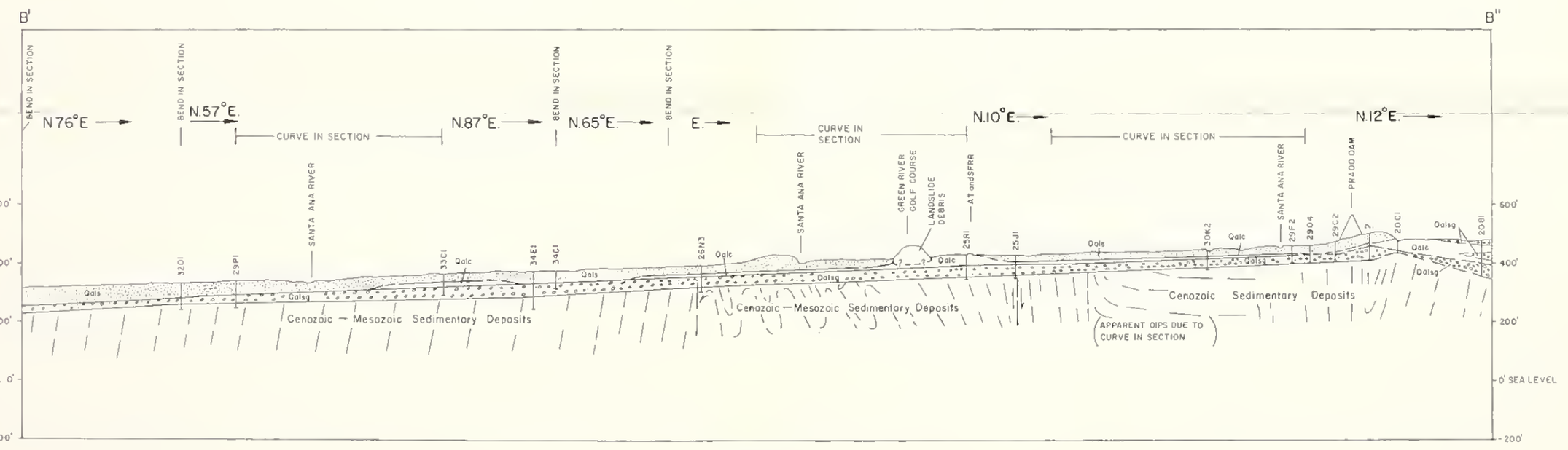
1981




SECTION A-A'




SECTION B-B'

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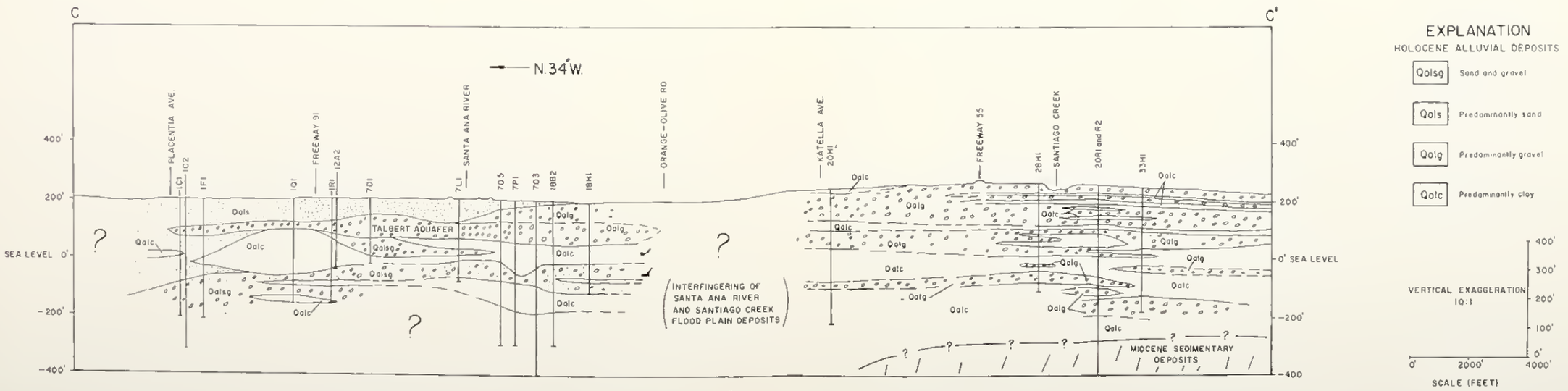


SECTION C-C'

## EXPLANATION

HOLOCENE ALLUVIAL DEPOSITS

- Qalsg — Sand and gravel
- Qals — Predominantly sand
- Qalg — Predominantly gravel
- Qalc — Predominantly clay

VERTICAL EXAGGERATION 10:1

SCALE (FEET) 0' 2000' 4000'

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# MINERAL LAND CLASSIFICATION OF THE GREATER LOS ANGELES AREA
## ORANGE COUNTY-TEMESCAL VALLEY PRODUCTION-CONSUMPTION REGION

# UPPER SANTIAGO CREEK RESOURCE AREA

### AGGREGATE RESOURCE SECTORS L-N

By R.V. Miller, R.E. Carbaley and T.P. Anderson

1981

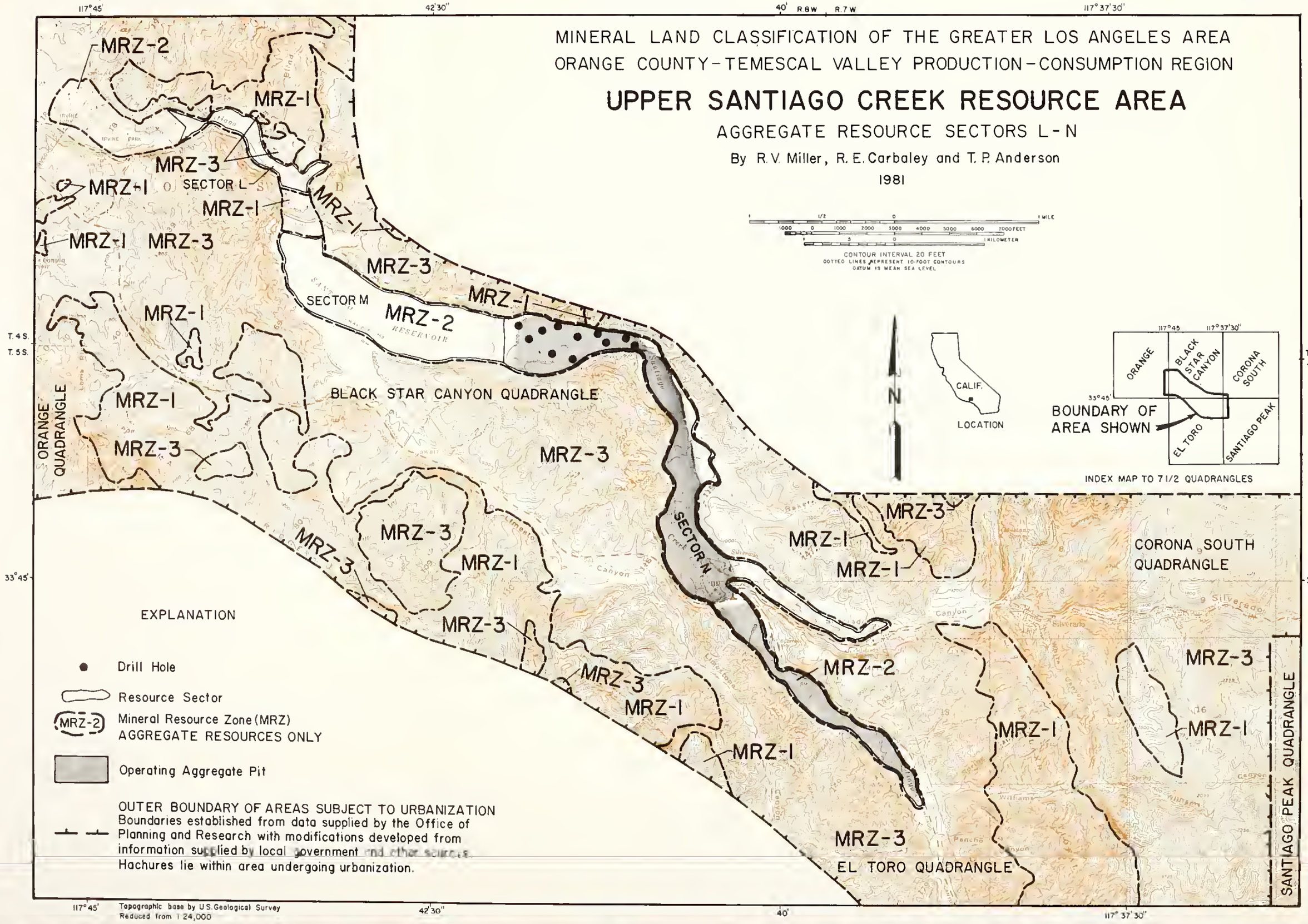

1/2
0
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL







INDEX MAP TO 7 1/2 QUADRANGLES




EXPLANATION

- Drill Hole
- Resource Sector
- (MRZ-2) Mineral Resource Zone (MRZ) AGGREGATE RESOURCES ONLY
- Operating Aggregate Pit
- OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
  Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources.
  Hachures lie within area undergoing urbanization.

Topographic base by U.S. Geological Survey
Reduced from 1:24,000

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# MINERAL LAND CLASSIFICATION OF THE GREATER LOS ANGELES AREA ORANGE COUNTY-TEMESCAL VALLEY PRODUCTION-CONSUMPTION REGION

## TEMESCAL WASH AND MAYHEW-COLDWATER FAN RESOURCE AREAS

AGGREGATE RESOURCE SECTORS O-S

By R.V. Miller, R.E. Corbaley and T.P. Anderson

1981

CONTOUR INTERVAL 20 FEET

CORONA NORTH QUADRANGLE

CORONA SOUTH QUADRANGLE

LAKE MATHEWS QUADRANGLE

SANTIAGO PEAK QUADRANGLE

ALBERHILL QUADRANGLE

SECTOR O

SECTOR P

SECTOR Q

SECTOR R

SECTOR S

MRZ-3

MRZ-2

MRZ-3

MRZ-3

MRZ-2

MRZ-3

### EXPLANATION

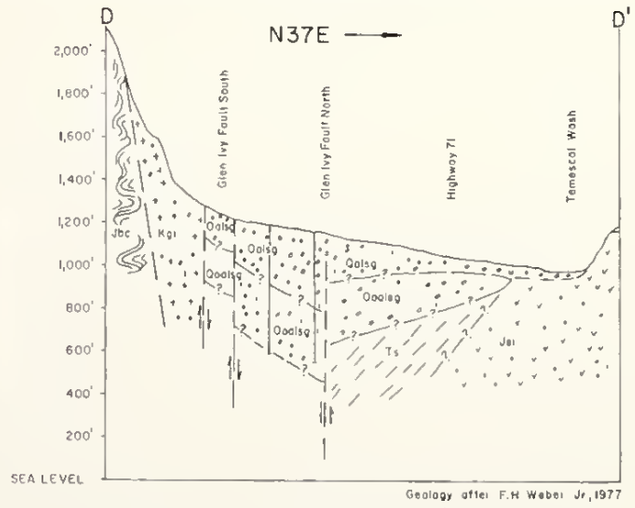
- Drill Hole
- D — D' Geologic Section Line
- Resource Sector
- (MRZ-2) Mineral Resource Zone (MRZ) AGGREGATE RESOURCES ONLY
- Operating Aggregate Pit
- Abandoned Aggregate Pit (either backfilled or aggregate completely removed)
- OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
  Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

BOUNDARY OF AREA SHOWN

CALIF — LOCATION

INDEX MAP TO 7 1/2' QUADRANGLES

### GENERALIZED GEOLOGIC SECTION SHOWING SAND AND GRAVEL DISTRIBUTION, MAYHEW-COLDWATER FAN RESOURCE AREA




Geology after F.H. Weber Jr., 1977

SECTION D-D'

EXPLANATION

| | | |
|---|---|---|
| | Holocene | |
| Qoalsg | Pleistocene | Alluvium predominantly sand and gravel |
| Qoalsg | Pleistocene | Older alluvium, predominantly sand and gravel |
| Ts | Paleocene | Silverado Formation |
| Kgr | Late Cretaceous | Granodioritic batholith rocks |
| Jsi | Jurassic | Santiago Peak Volcanics intrusive |
| Jbc | Jurassic | Bedford Canyon Formation |

VERTICAL EXAGGERATION 5:1

Topographic base by US Geological Survey
Reduced from 1:24,000

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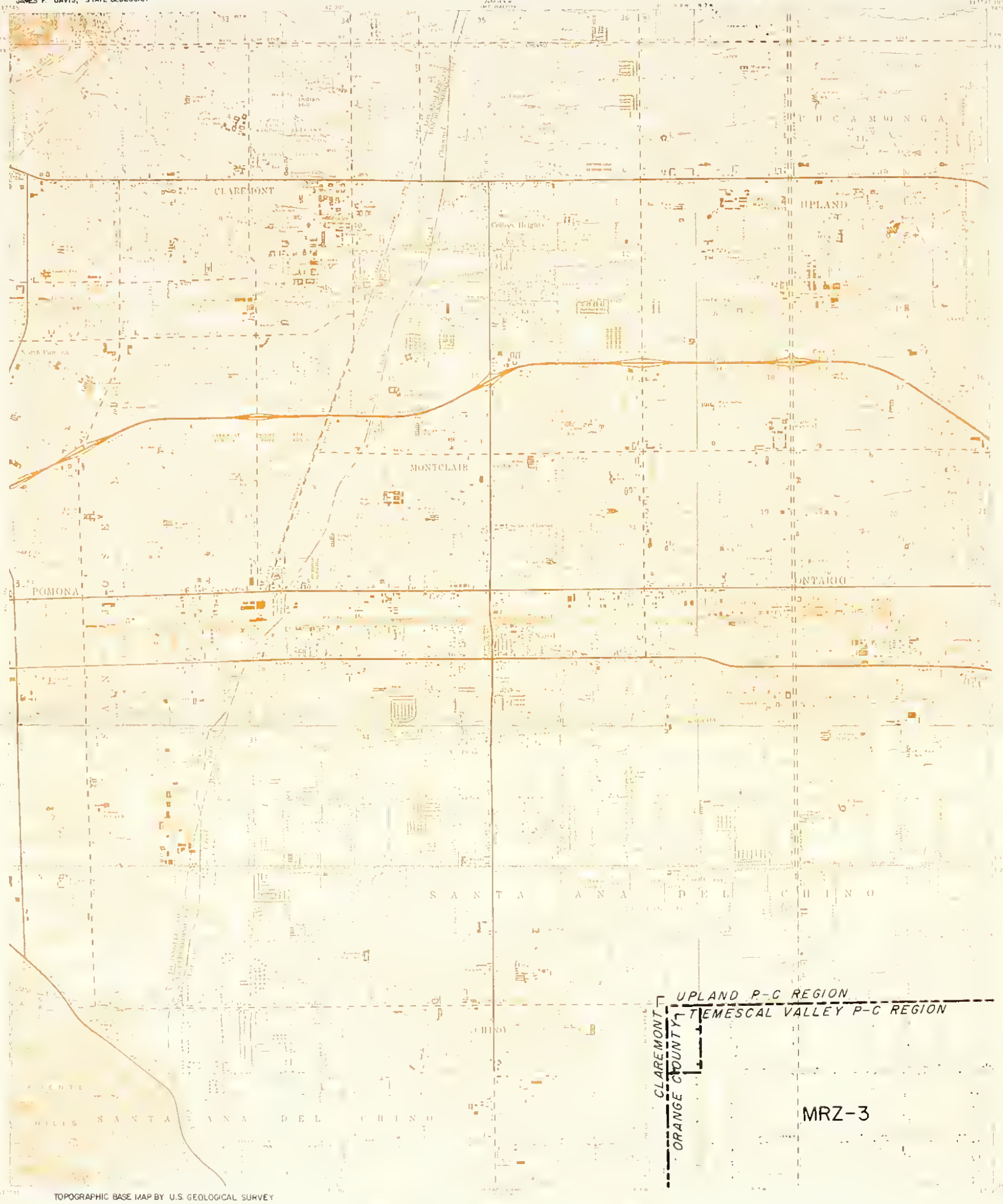
SPECIAL REPORT 143
PLATE 3.7




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

- MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
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- MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols.

MAGNETIC NORTH
AND DECLINATION

ONTARIO, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

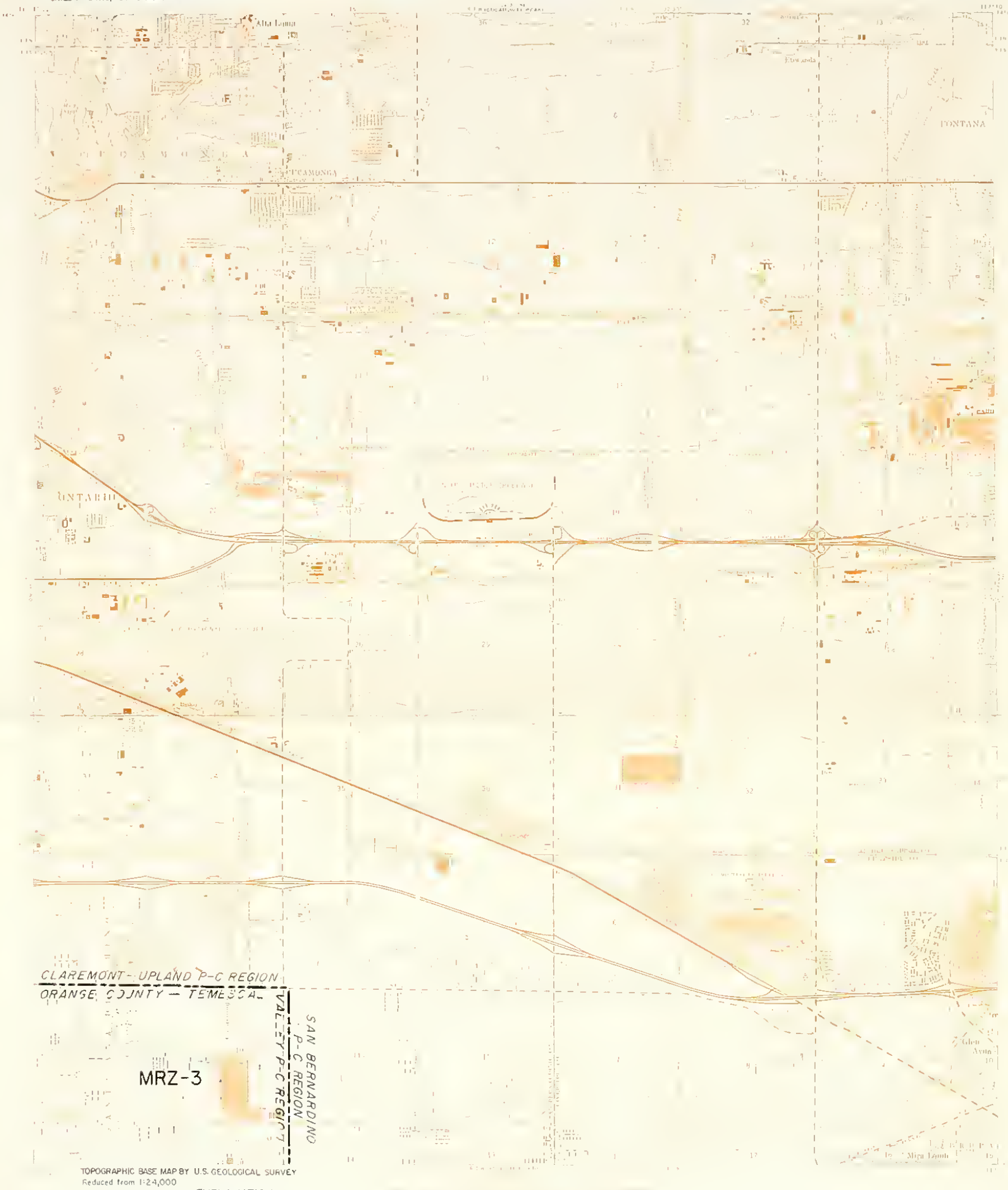
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

STATE GEOLOGIST

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

QUASTI QUADRANGLE
SPECIAL REPORT 143
PLATE 3.8




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

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See text for additional explanation of MRZ Symbols.

15°

MAGNETIC NORTH
AND DECLINATION

QUASTI, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
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THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SOUTH GATE QUADRANGLE
SPECIAL REPORT 143
PLATE 3.9

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols.

CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

15°

MAGNETIC NORTH
AND DECLINATION

SOUTH GATE, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

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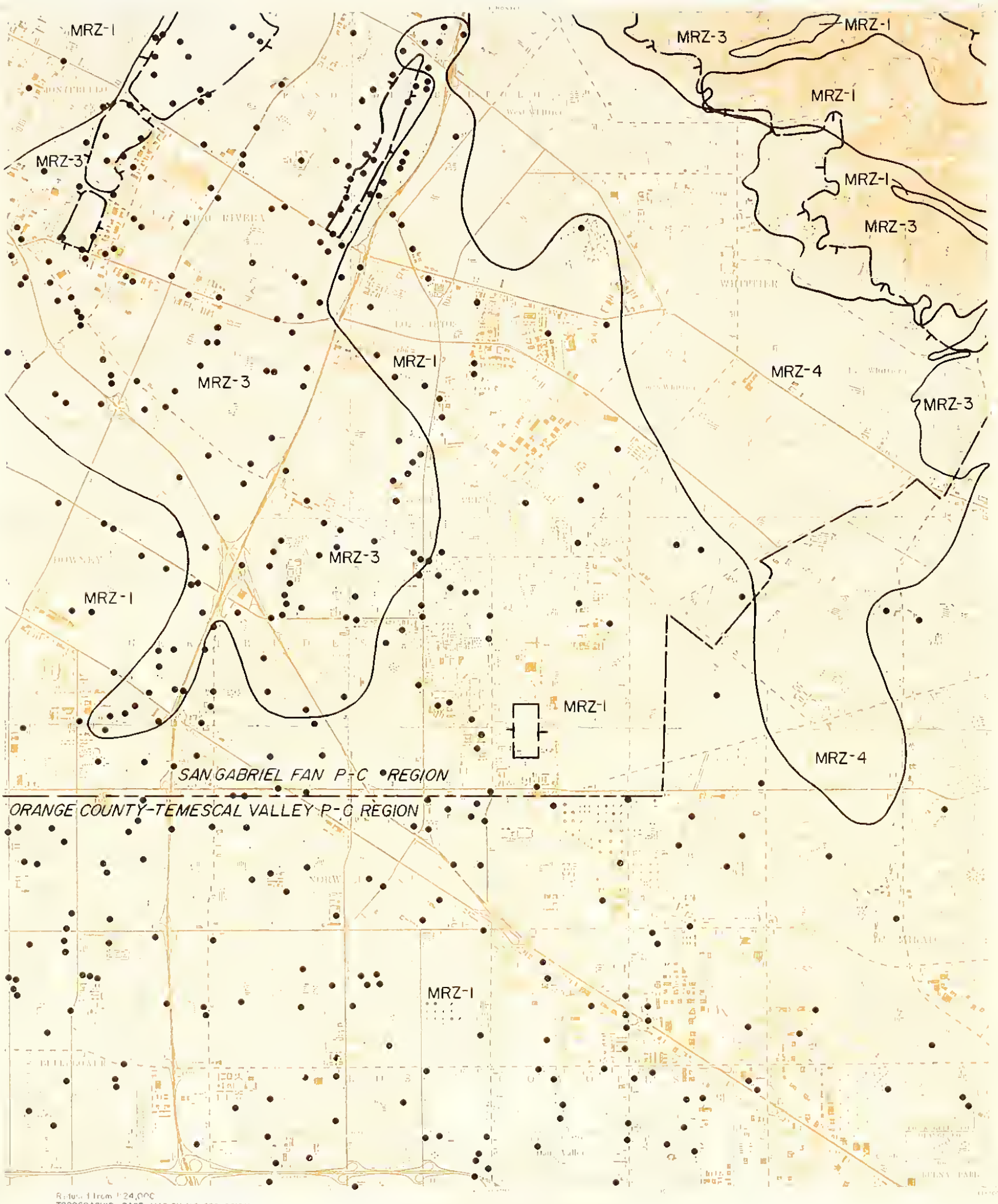
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

WHITTIER QUADRANGLE
SPECIAL REPORT 143
PLATE 3.10




Reduced from 1:24,000
TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

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See text for additional explanation of MRZ Symbols

N

WHITTIER, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

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JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

LA HABRA QUADRANGLE
SPECIAL REPORT 143
PLATE 3.11

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

Drill hole

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See text for additional explanation of MRZ Symbols.

10°

MAGNETIC NORTH
AND DECLINATION

LA HABRA, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
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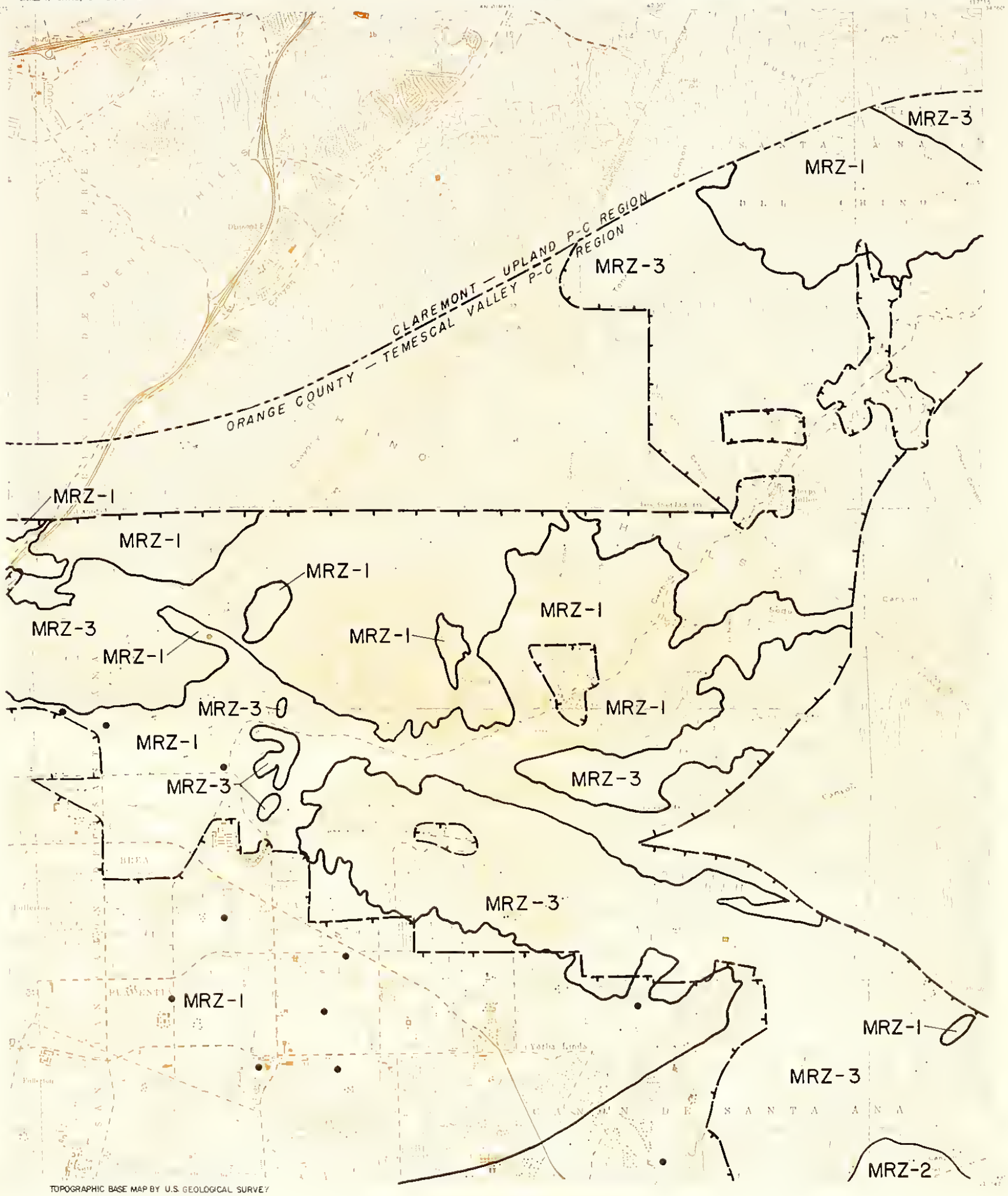
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

YORBA LINDA QUADRANGLE
SPECIAL REPORT 143
PLATE 3.12




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

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PRODUCTION-CONSUMPTION REGION BOUNDARY
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See text for additional explanation of MRZ Symbols.

15°

MAGNETIC NORTH
AND DECLINATION

YORBA LINDA, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

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JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

PRADO DAM QUADRANGLE
SPECIAL REPORT 143
PLATE 3.13

CLAREMONT — UPLAND P-C REGION
ORANGE COUNTY — TEMESCAL VALLEY P-C REGION

MRZ-1
MRZ-3
MRZ-1
MRZ-1
MRZ-3
MRZ-3
MRZ-1
MRZ-1
MRZ-2
MRZ-3
MRZ-2
MRZ-1
MRZ-1
MRZ-2
MRZ-3
MRZ-3
MRZ-2
MRZ-1

TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

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See text for additional explanation of MRZ Symbols.

15°

MAGNETIC NORTH
AND DECLINATION

PRADO DAM, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

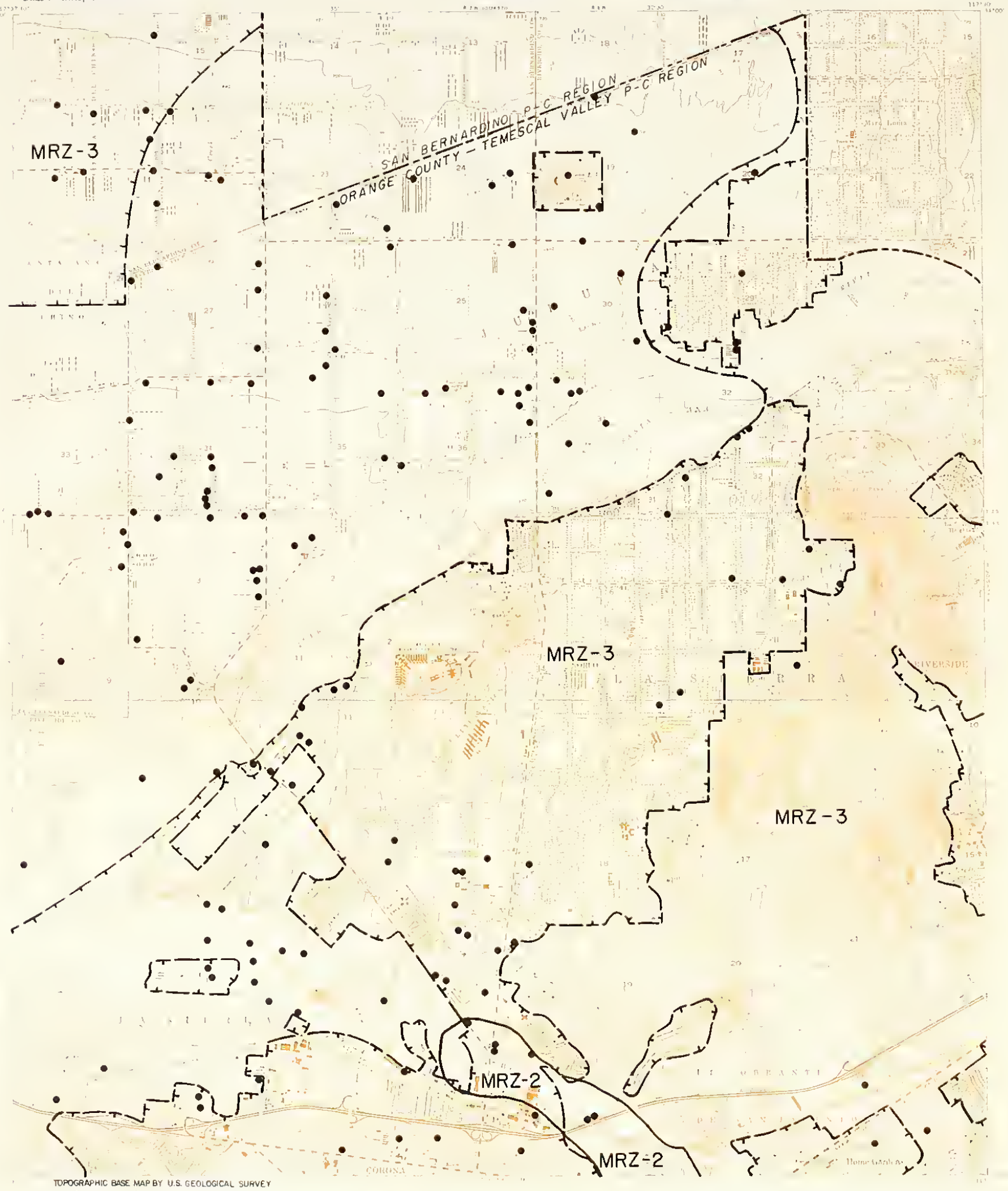
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

STATE GEOLOGIST

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

CORONA NORTH QUADRANGLE
SPECIAL REPORT 143
PLATE 3.14

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Reduced from 1:24,000

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See text for additional explanation of MRZ Symbols.

16°

MAGNETIC NORTH
AND DECLINATION

CORONA NORTH, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

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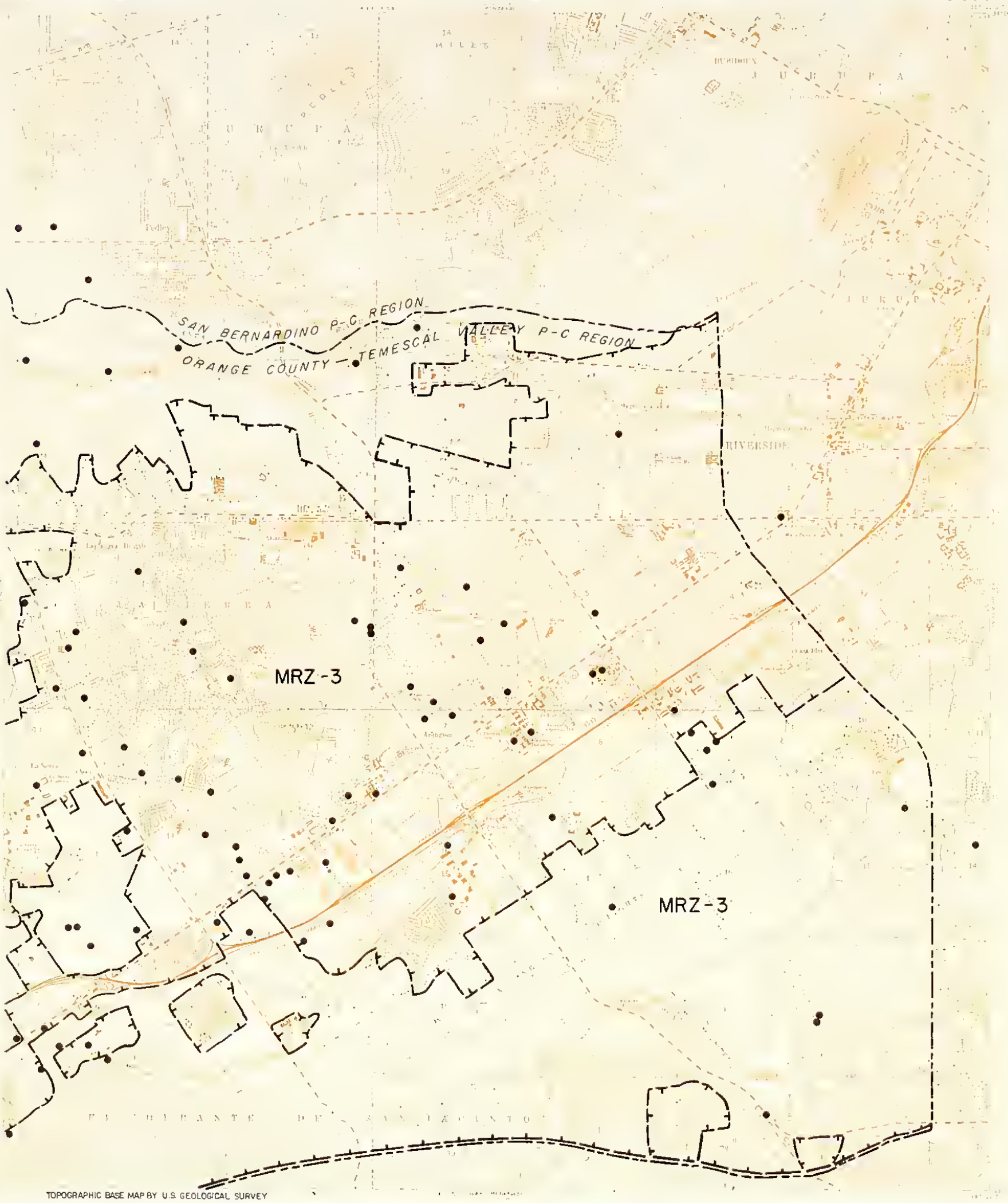
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

RIVERSIDE WEST QUADRANGLE
SPECIAL REPORT 143
PLATE 3.15

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Reduced from 1:24,000

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15°

MAGNETIC NORTH
AND DECLINATION

RIVERSIDE WEST, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

LONG BEACH QUADRANGLE
SPECIAL REPORT 143
PLATE 3.16

TOPOGRAPHIC BASE BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

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[see text for discussion]

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MAGNETIC NORTH
AND DECLINATION

LONG BEACH, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

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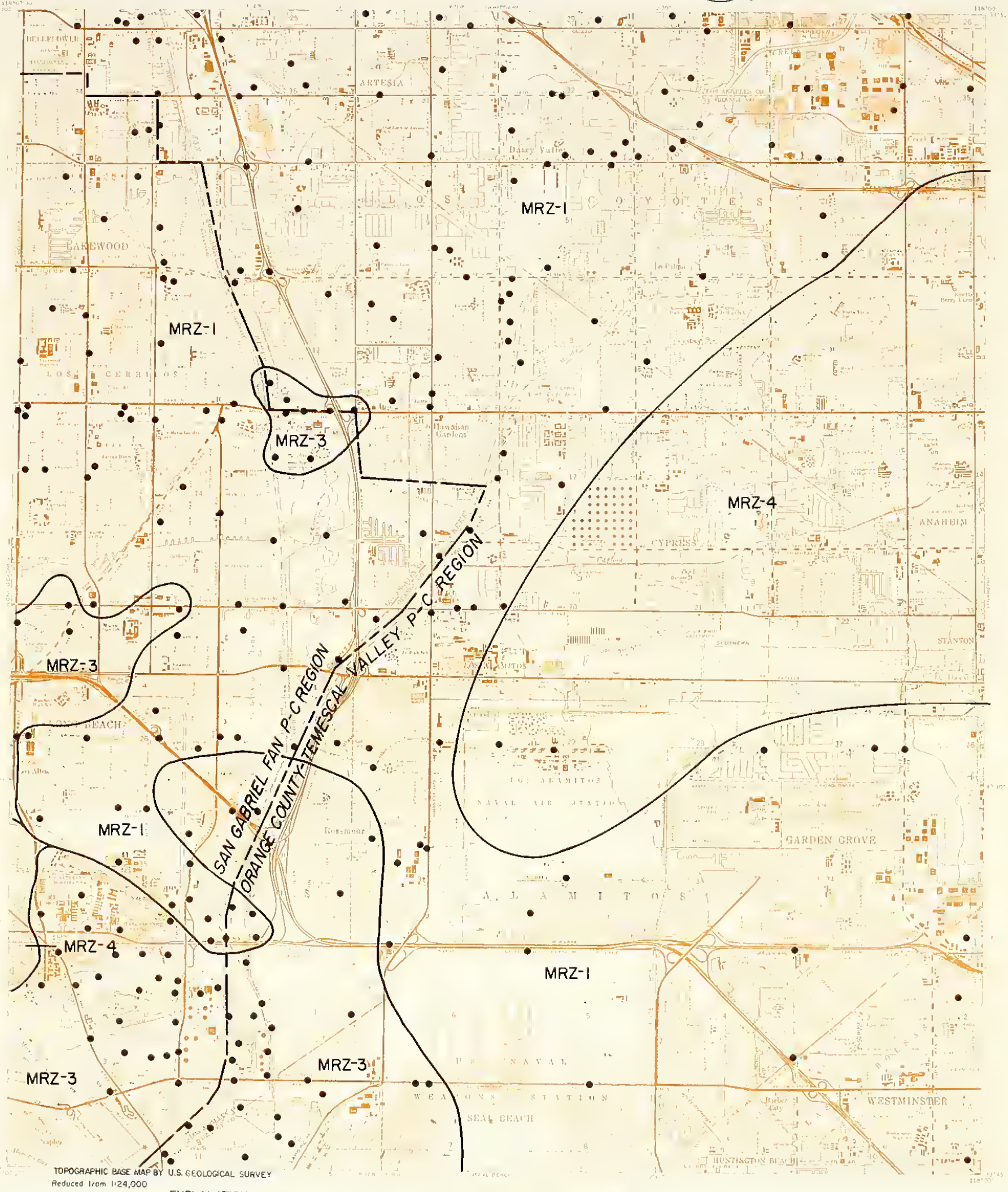
STATE GEOLOGIST

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

LOS ALAMITOS QUADRANGLE
SPECIAL REPORT 143
PLATE 3.17




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

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15°

MAGNETIC NORTH
AND DECLINATION

LOS ALAMITOS, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

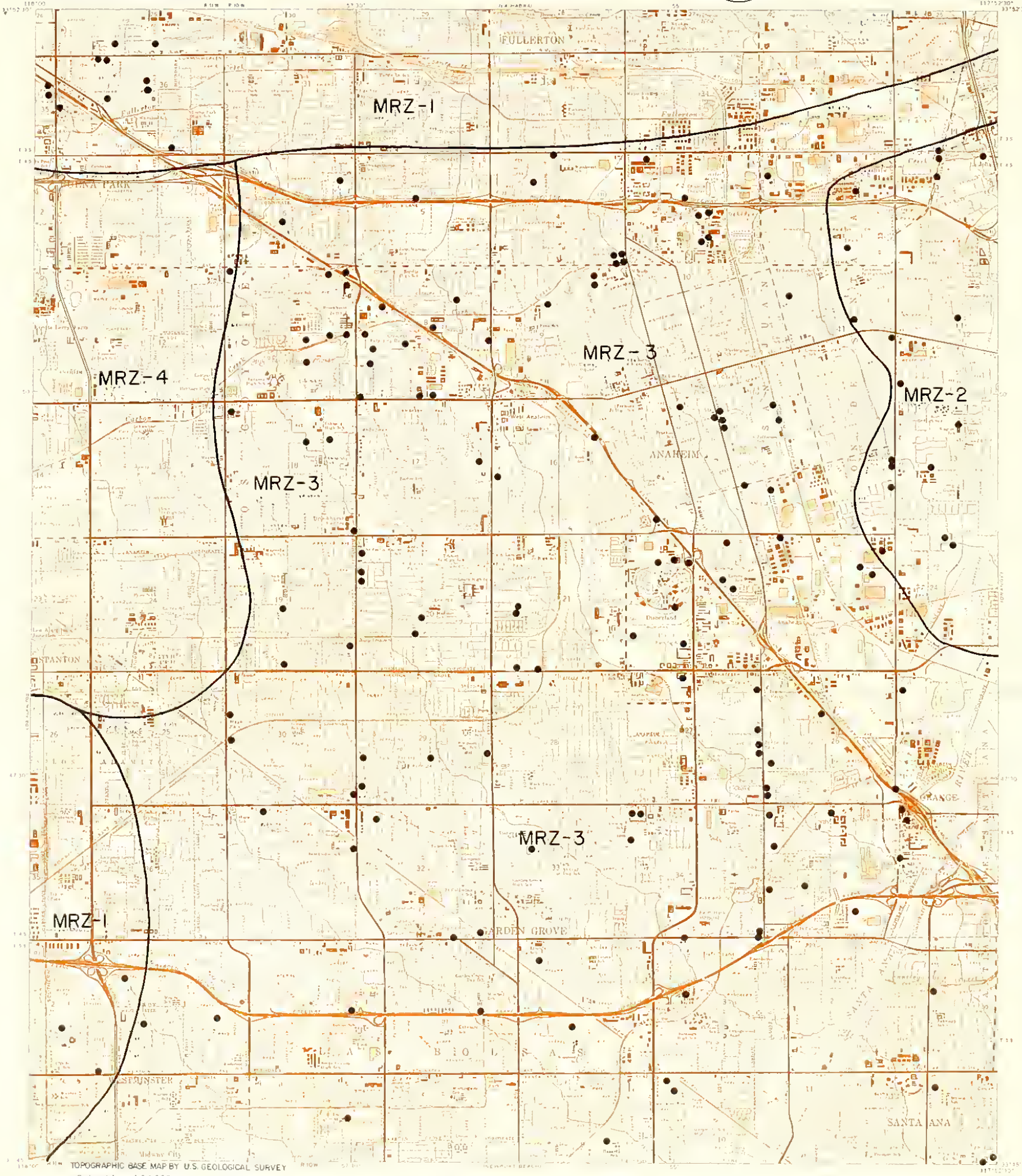
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

ANAHEIM QUADRANGLE
SPECIAL REPORT 143
PLATE 3.18




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

## EXPLANATION

Drill hole

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(see text for discussion)

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15°

MAGNETIC NORTH
AND DECLINATION

ANAHEIM, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

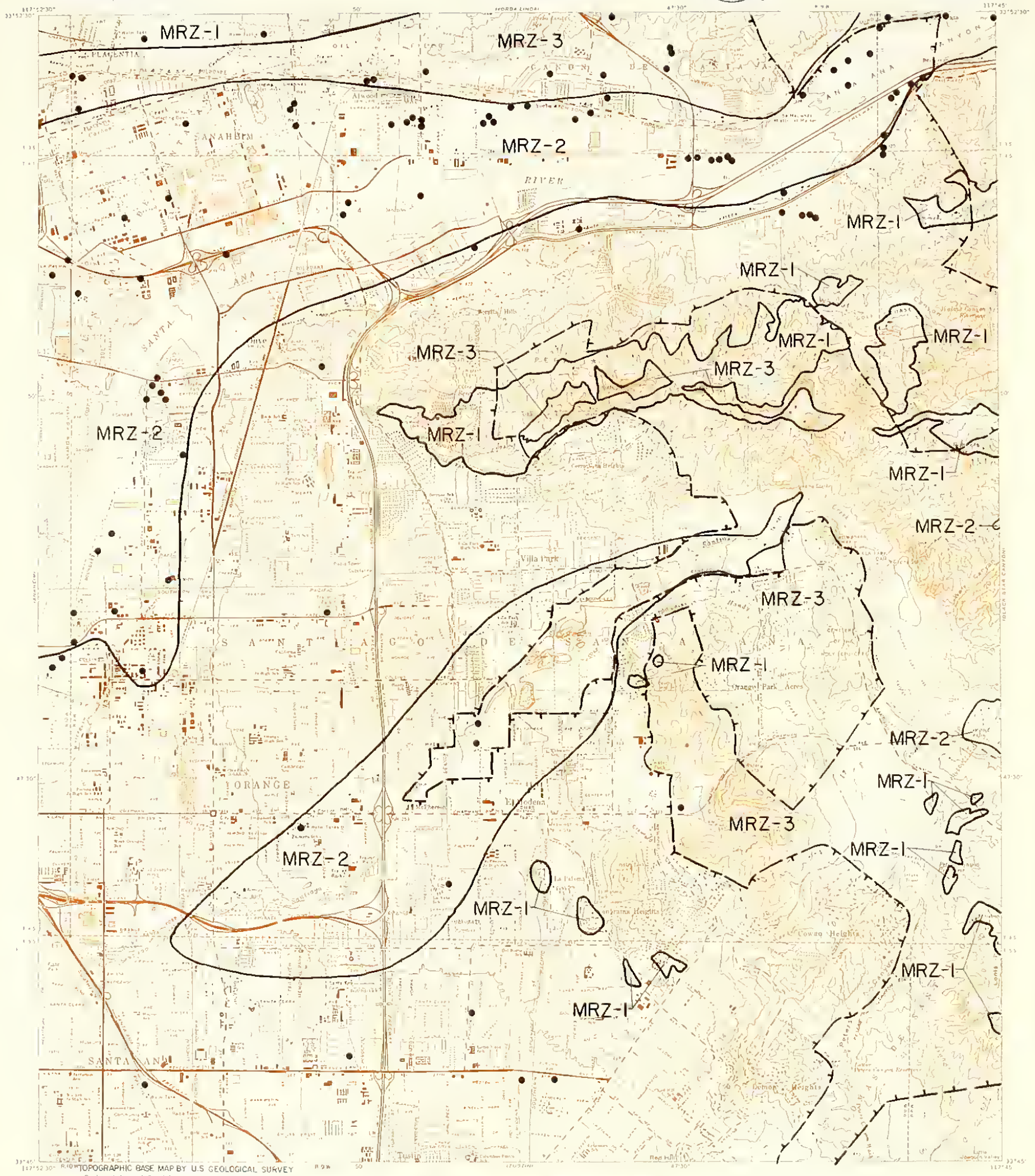
PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

ORANGE QUADRANGLE
SPECIAL REPORT 143
PLATE 3.19




TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

## EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
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15°

MAGNETIC NORTH
AND DECLINATION

ORANGE, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
STATE GEOLOGIST

CALIFORNIA DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

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MAGNETIC NORTH
AND DECLINATION

BLACK STAR CANYON, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

James F. Davis
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DEPARTMENT OF CONSERVATION

CORONA SOUTH QUADRANGLE
SPECIAL REPORT 143
PLATE 3.21

MRZ-3

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area.

PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.

MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists.

MRZ-3 Areas containing mineral deposits the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

MRZ-2

See text for additional explanation of MRZ Symbols.

15°

MAGNETIC NORTH
AND DECLINATION

CORONA SOUTH, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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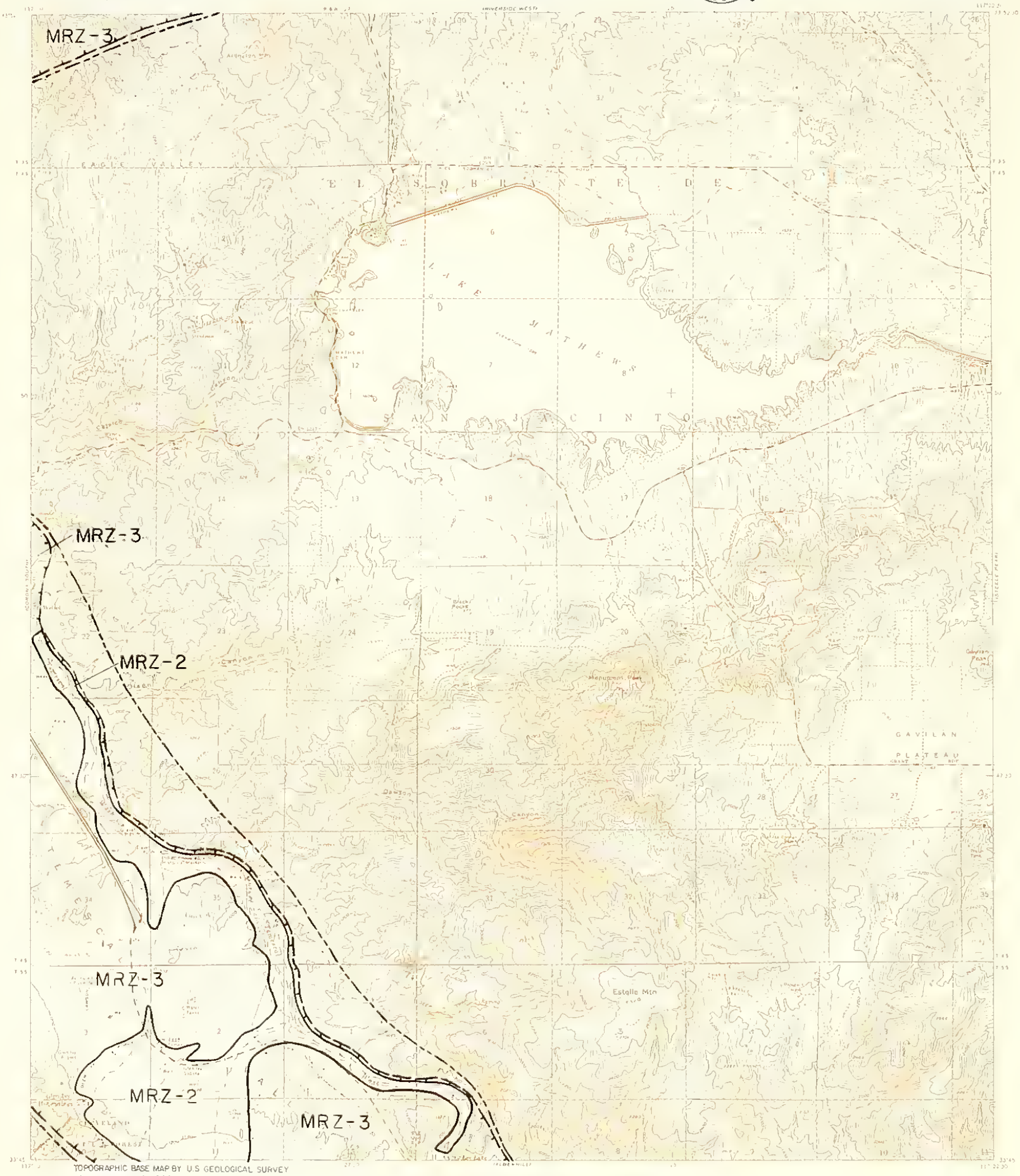
DEPARTMENT OF CONSERVATION

LAKE MATHEWS QUADRANGLE
SPECIAL REPORT 143
PLATE 3.22




TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

LAKE MATHEWS, CALIF

## EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.

EXISTING URBAN BOUNDARIES
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

- MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
- MRZ-2 Areas where adequate information indicates that significant mineral deposits are present or where it is judged that a high likelihood for their presence exists
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See text for additional explanation of MRZ Symbols.

15°

MAGNETIC NORTH
AND DECLINATION

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SEAL BEACH QUADRANGLE
SPECIAL REPORT 143
PLATE 3.23

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

- Drill hole
- OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION — Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization
- EXISTING URBAN BOUNDARIES — Boundaries established by the Office of Planning and Research and by data supplied by local government agencies and other sources to reflect present conditions. Hachures lie within urban area.
- PRODUCTION-CONSUMPTION REGION BOUNDARY (see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

- MRZ-1 — Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
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See text for additional explanation of MRZ Symbols

CONTOUR INTERVAL 5 FEET

15°

MAGNETIC NORTH
AND DECLINATION

SEAL BEACH, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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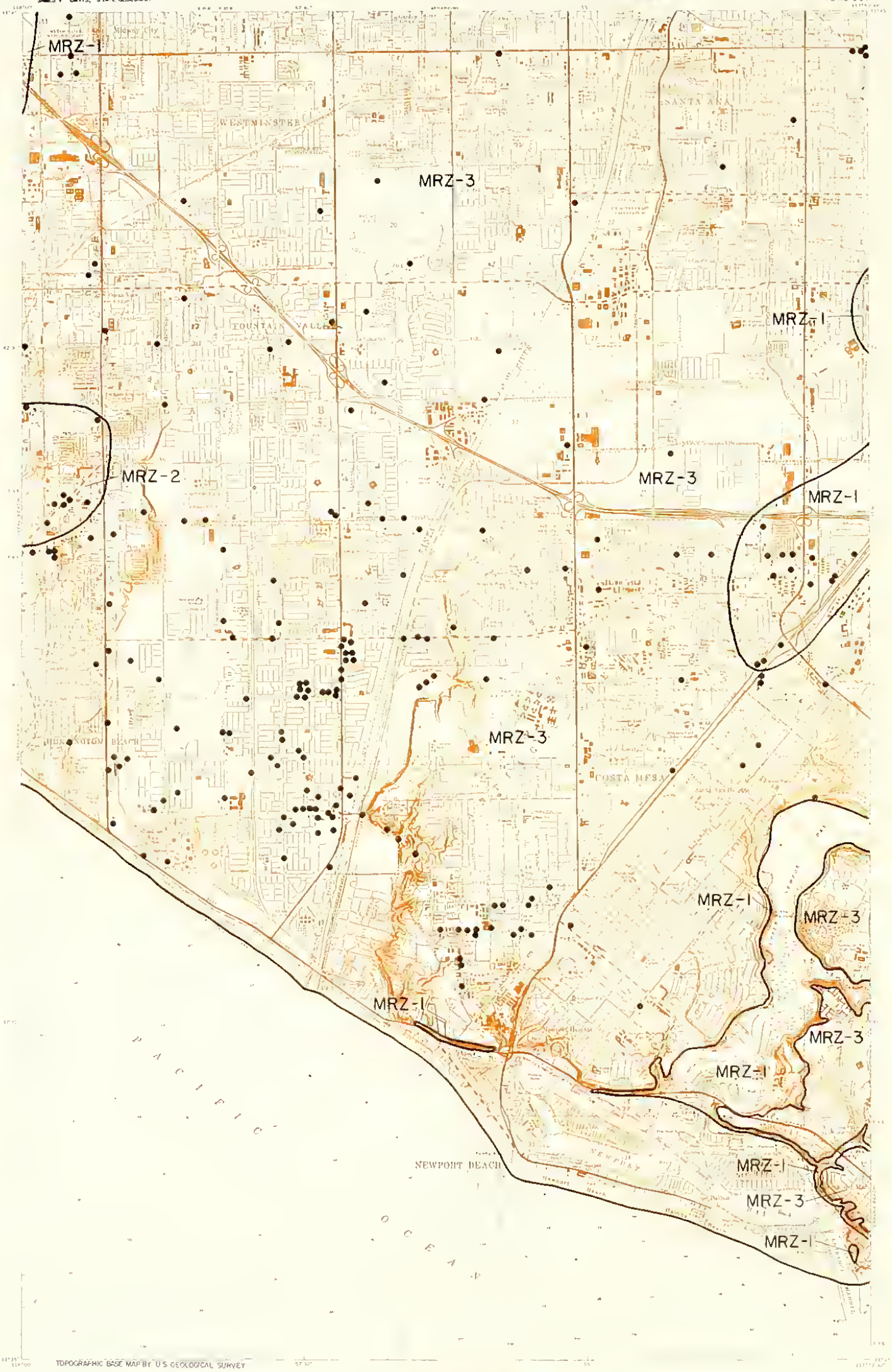
DEPARTMENT OF CONSERVATION

NEWPORT BEACH QUADRANGLE
SPECIAL REPORT 143
PLATE 3.24




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

Drill hole

OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols

CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

MAGNETIC NORTH
AND DECLINATION

NEWPORT BEACH, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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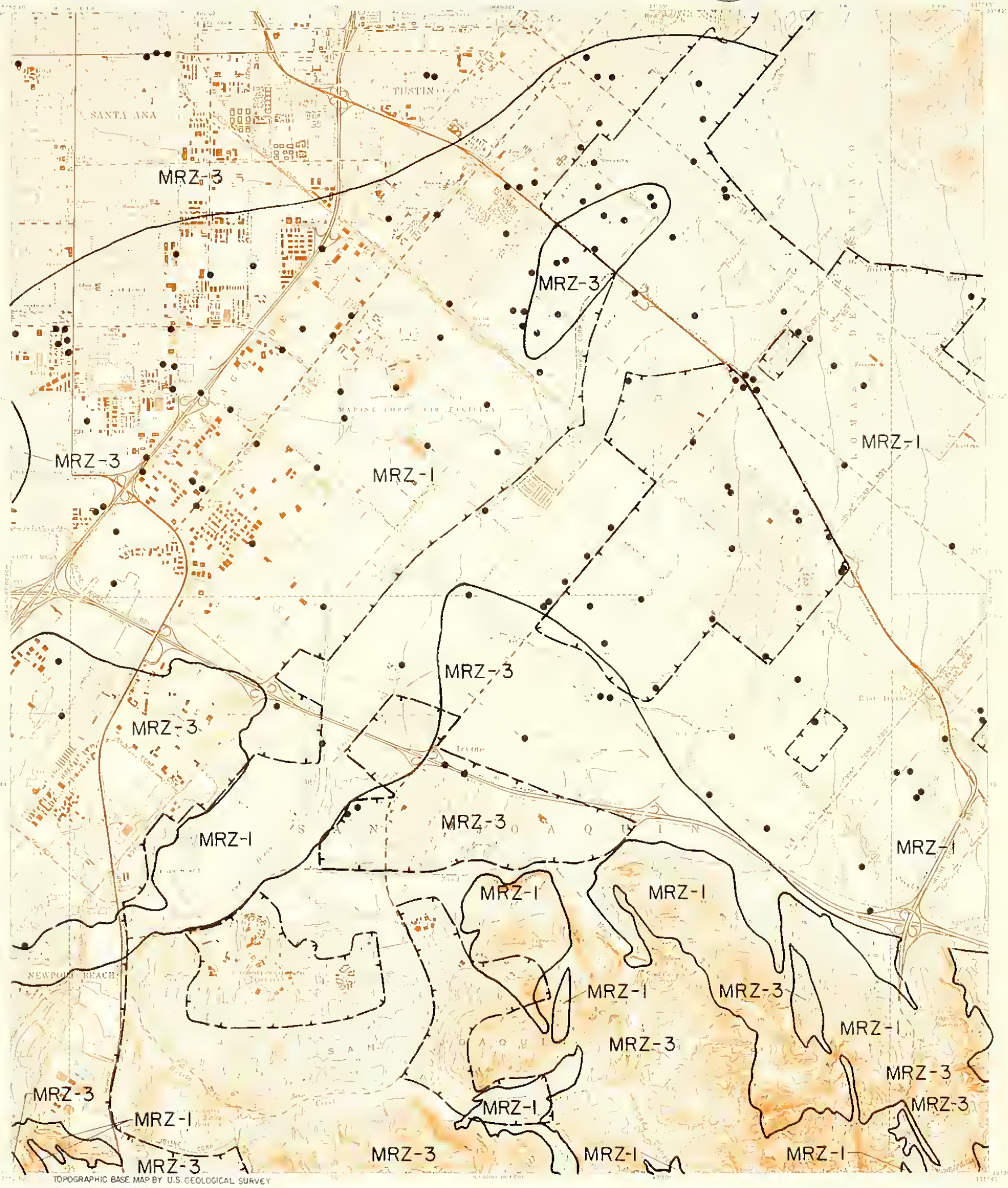
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

TUSTIN QUADRANGLE
SPECIAL REPORT 143
PLATE 3.9




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

MAGNETIC NORTH
AND DECLINATION

TUSTIN, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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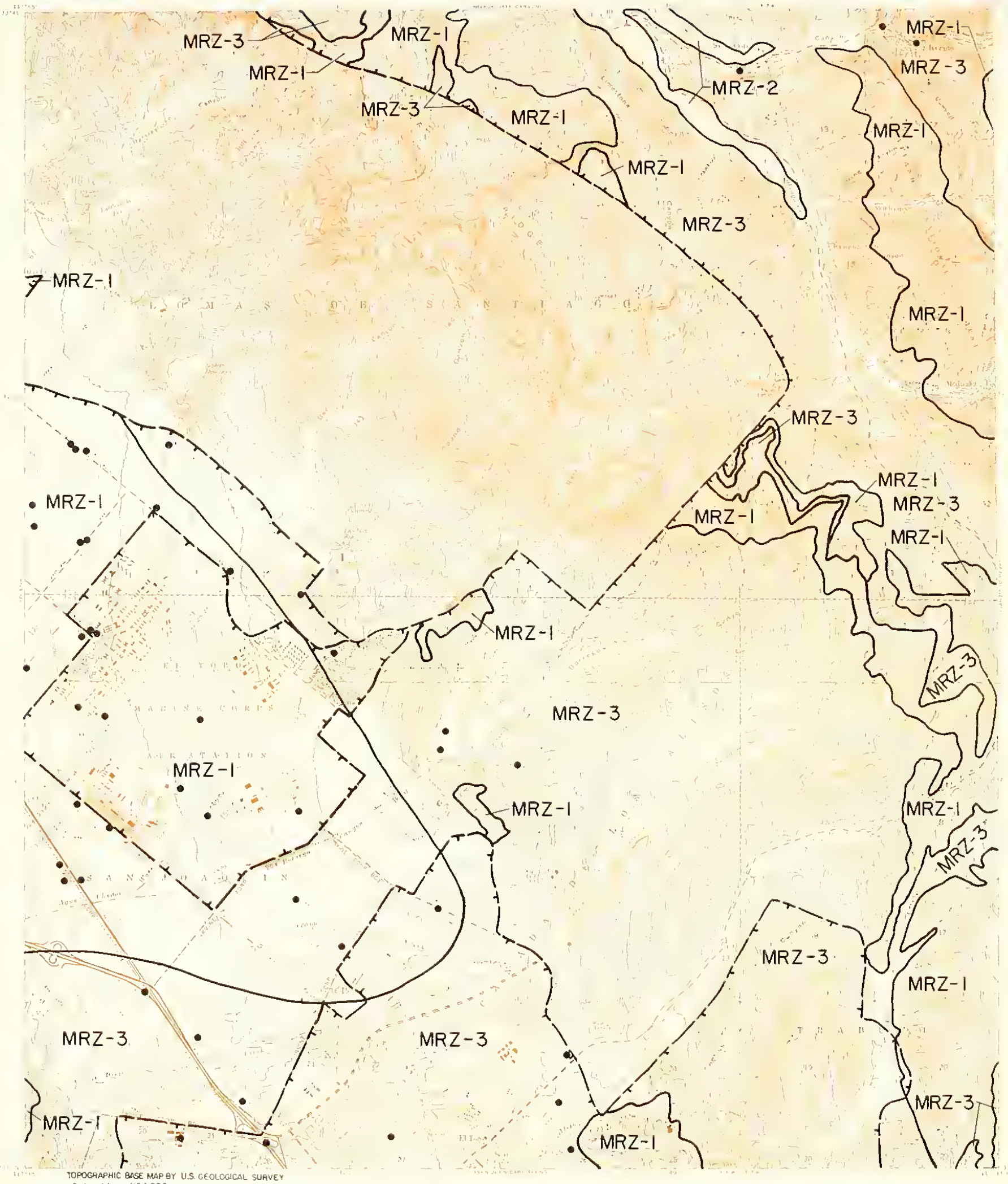
DEPARTMENT OF CONSERVATION

EL TORO QUADRANGLE
SPECIAL REPORT 143
PLATE 3.26




## EXPLANATION

- Drill hole
- OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION. Boundaries established from data supplied by the Office of Planning and Research with modifications developed from information supplied by local government and other sources. Hachures lie within area undergoing urbanization.
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- PRODUCTION-CONSUMPTION REGION BOUNDARY (see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols.

15°

MAGNETIC NORTH AND DECLINATION

EL TORO, CALIF

# MINERAL LAND CLASSIFICATION MAP

## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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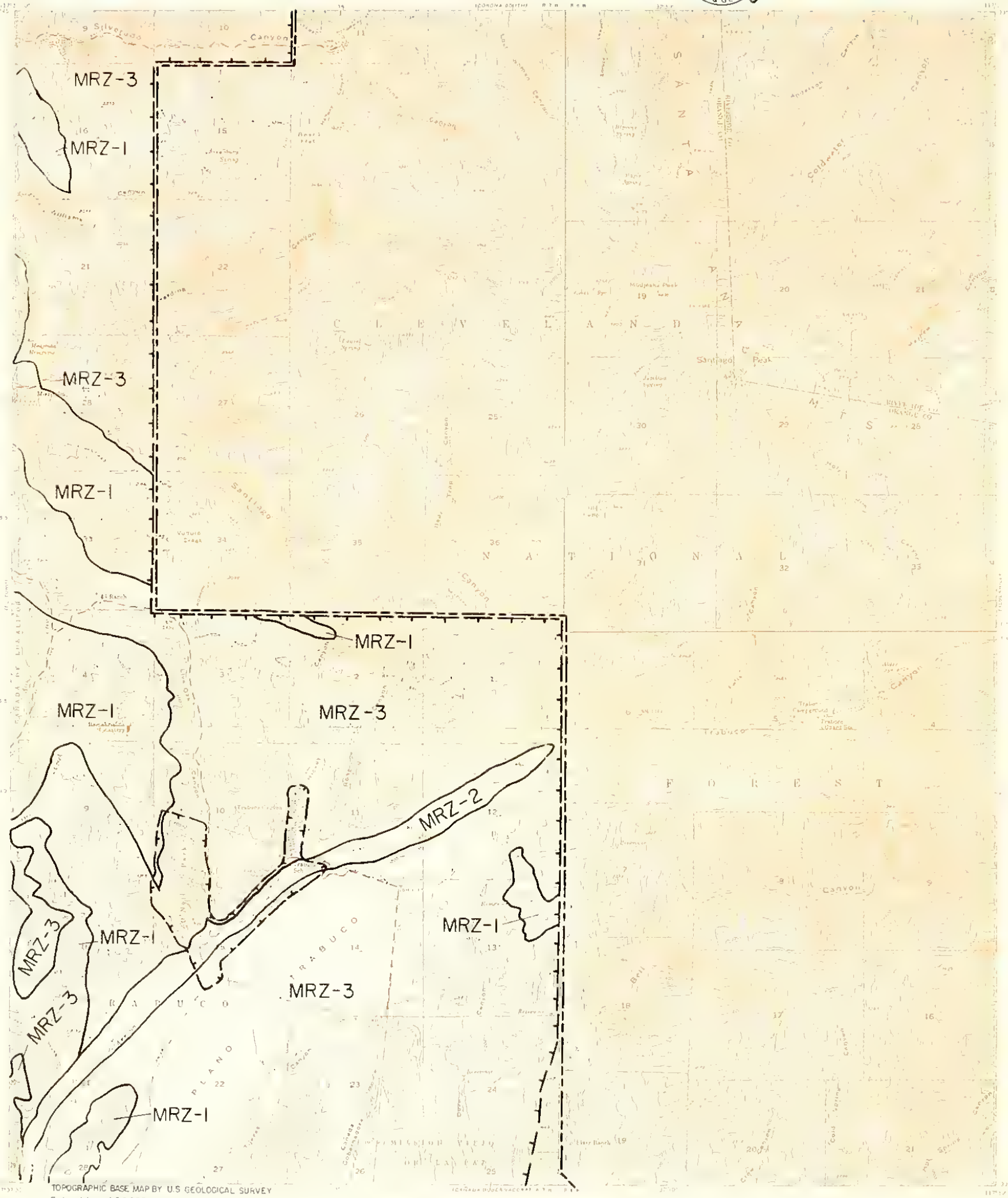
DEPARTMENT OF CONSERVATION

SANTIAGO PEAK QUADRANGLE
SPECIAL REPORT 143
PLATE 3.27




TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

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PRODUCTION-CONSUMPTION REGION BOUNDARY
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MINERAL RESOURCE ZONE BOUNDARIES

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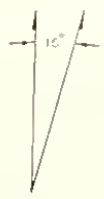
See text for additional explanation of MRZ Symbols




MAGNETIC NORTH
AND DECLINATION

SANTIAGO PEAK, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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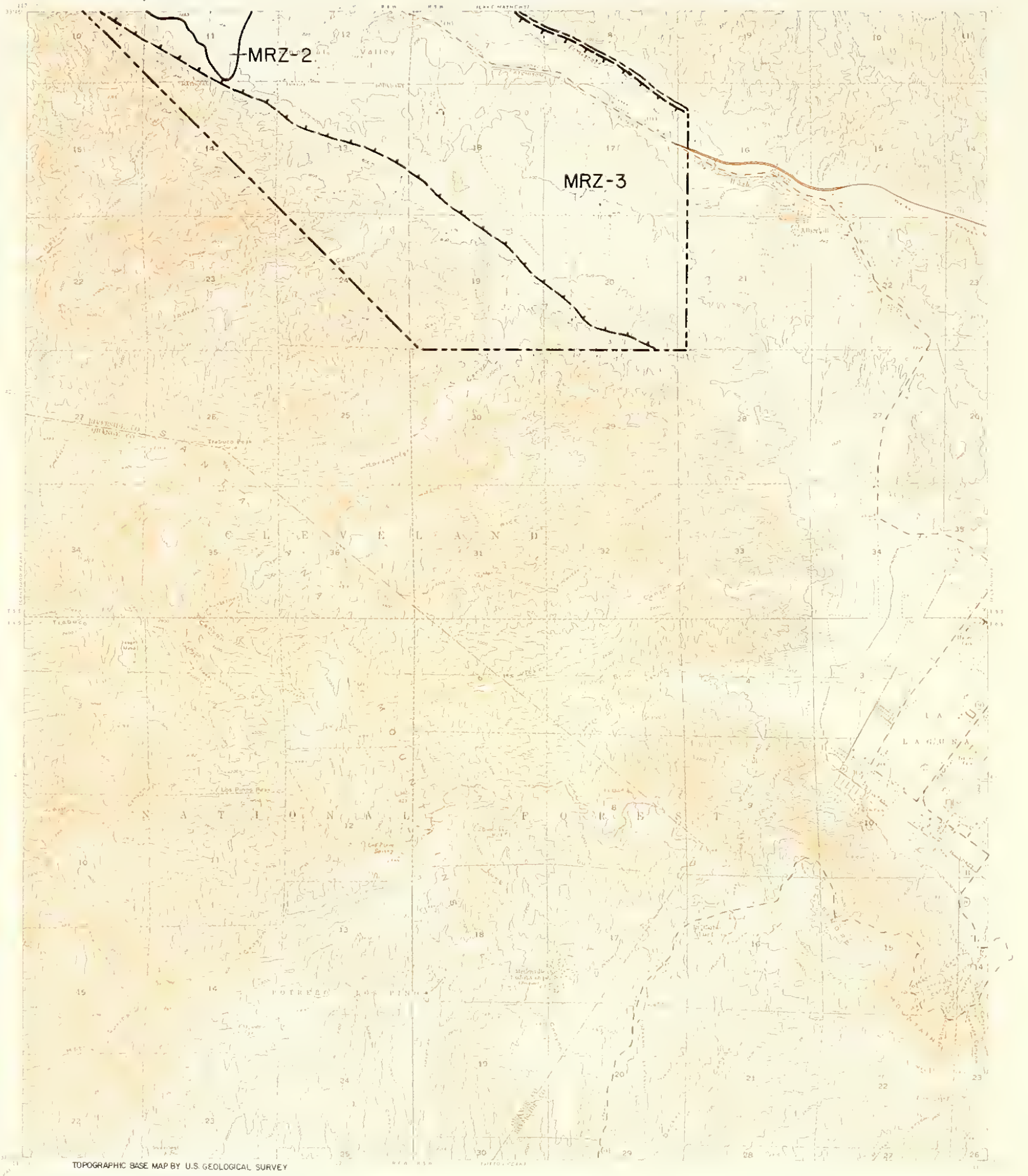
DEPARTMENT OF CONSERVATION

ALBERHILL QUADRANGLE
SPECIAL REPORT 143
PLATE 3.28




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

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See text for additional explanation of MRZ Symbols.

15°

MAGNETIC NORTH
AND DECLINATION

ALBERHILL CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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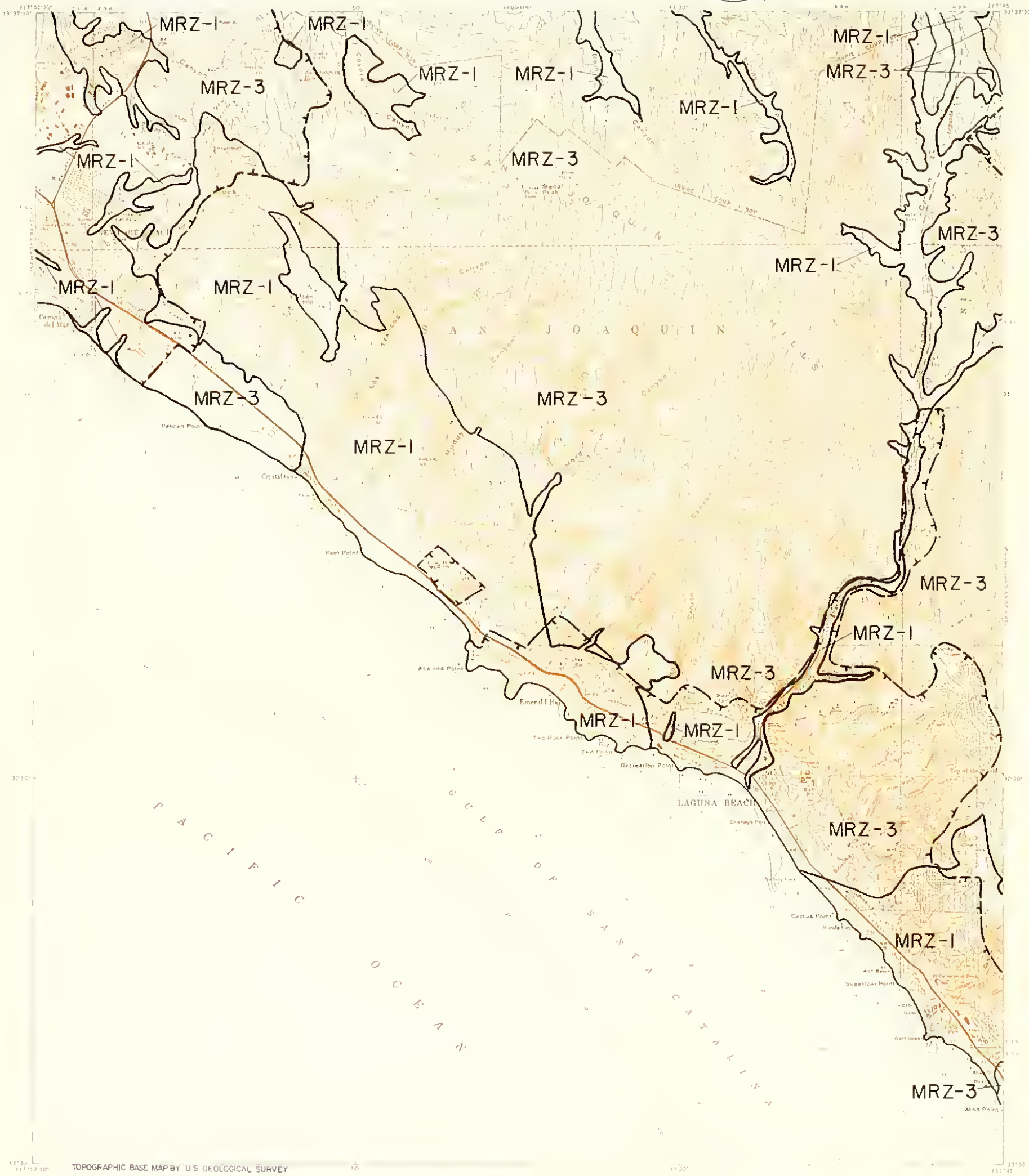
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

LAGUNA BEACH QUADRANGLE
SPECIAL REPORT 143
PLATE 3.29




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

- Drill hole
- OUTER BOUNDARY OF AREAS SUBJECT TO URBANIZATION
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- PRODUCTION-CONSUMPTION REGION BOUNDARY
  (see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

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15°

MAGNETIC NORTH
AND DECLINATION

LAGUNA BEACH, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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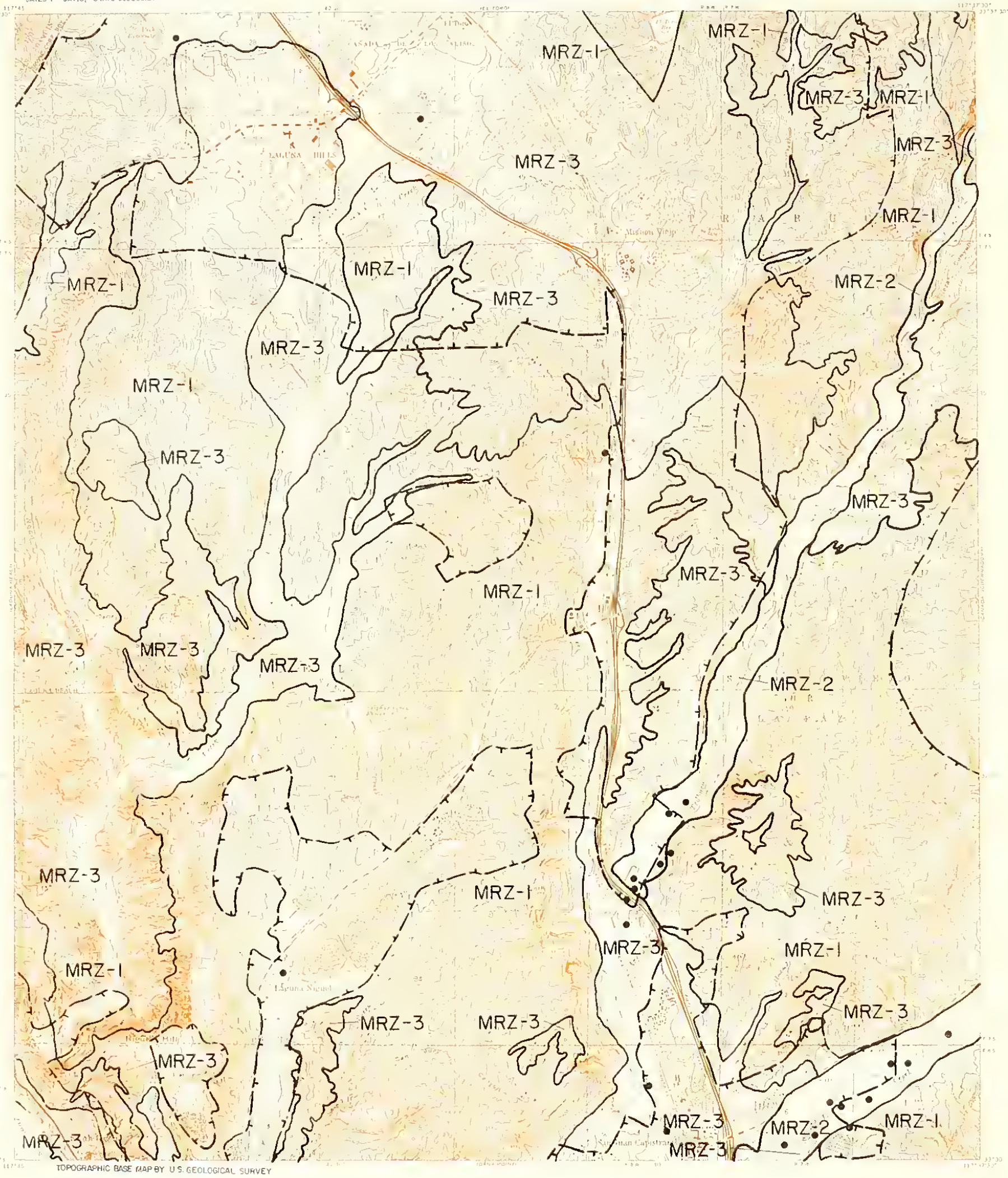
DEPARTMENT OF CONSERVATION

SAN JUAN CAPISTRANO QUADRANGLE
SPECIAL REPORT 143
PLATE 3.10




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

MRZ-2

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See text for additional explanation of MRZ Symbols

15°

MAGNETIC NORTH
AND DECLINATION

SAN JUAN CAPISTRANO, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

CAÑADA GOBERNADORA QUADRANGLE
SPECIAL REPORT 143
PLATE 3.31

MRZ-1
MRZ-3
MRZ-2
MRZ-3

T R A B U C O

M I S S I O N V I E J O

MRZ-1
MRZ-3
MRZ-3
MRZ-2
MRZ-1
MRZ-3
MRZ-1
MRZ-1

TOPOGRAPHIC BASE MAP BY U.S GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

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PRODUCTION-CONSUMPTION REGION BOUNDARY
(see text for discussion)

MINERAL RESOURCE ZONE BOUNDARIES

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15°

MAGNETIC NORTH
AND DECLINATION

CAÑADA GOBERNADORA, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

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THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

DANA POINT QUADRANGLE
SPECIAL REPORT 143
PLATE 33Z

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

- Drill hole

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PRODUCTION-CONSUMPTION REGION BOUNDARY
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MINERAL RESOURCE ZONE BOUNDARIES

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CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS

15°

MAGNETIC NORTH
AND DECLINATION

DANA POINT, CALIF.

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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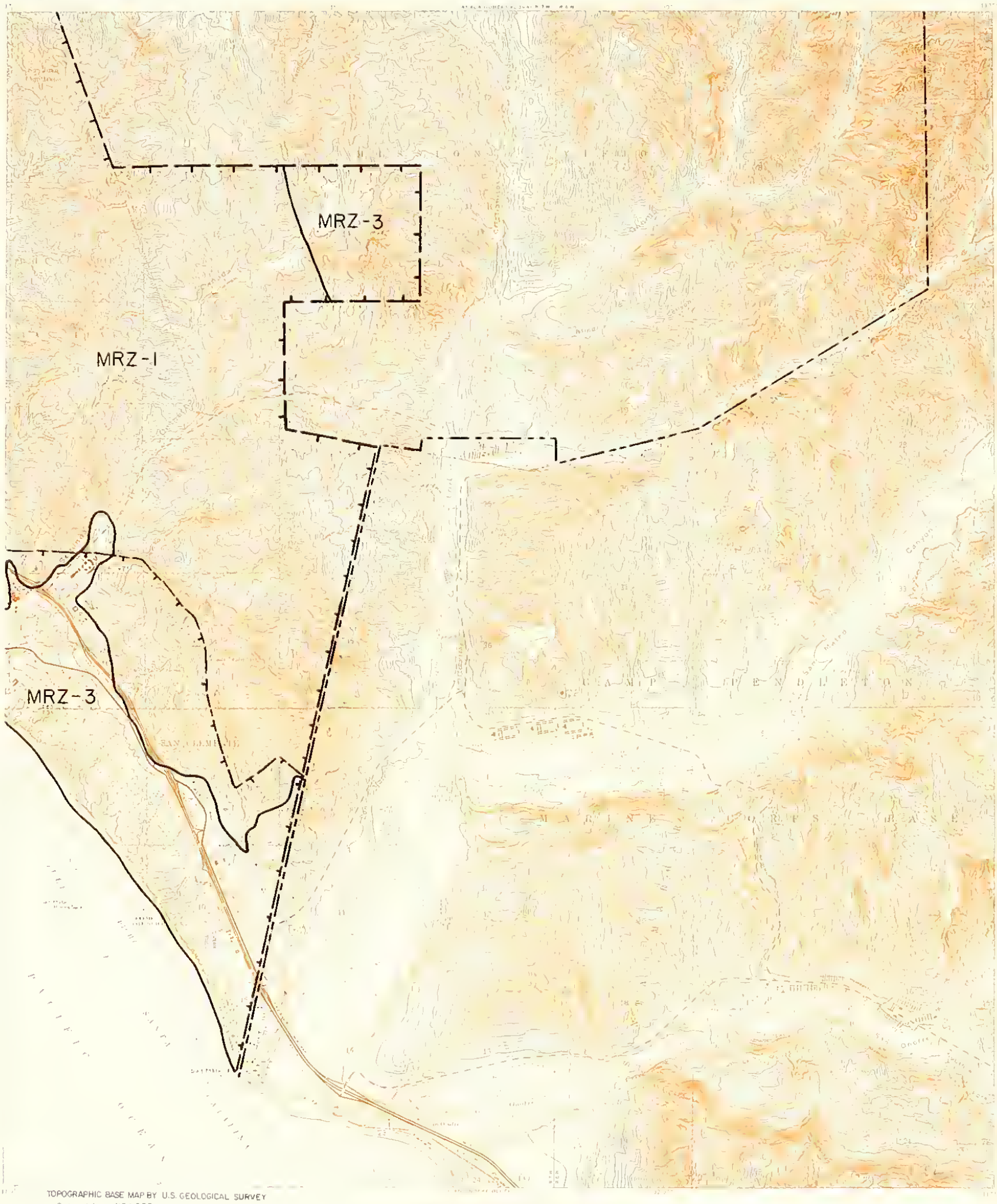
DEPARTMENT OF CONSERVATION

SAN CLEMENTE QUADRANGLE
SPECIAL REPORT 143
PLATE 3.33




TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

## EXPLANATION

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(see text for discussion)

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See text for additional explanation of MRZ Symbols.

15°

MAGNETIC NORTH
AND DECLINATION

SAN CLEMENTE, CALIF

# MINERAL LAND CLASSIFICATION MAP
## AGGREGATE RESOURCES ONLY

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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JAMES F. DAVIS, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION

SPECIAL REPORT 143
PLATE 3.34

118°00'

34°00'

SAN GABRIEL P-C REGION

CLAREMONT-UPLAND P-C REGION

SAN BERNARDINO P-C REGION

ORANGE COUNTY-TEMESCAL VALLEY P-C REGION

San Gabriel Resource Areas

Claremont-Upland Resource Areas

San Bernardino Resource Areas

Sectors D E F

Sector A

Sector B

Sector C

Sector G

Sector H

Sector I

Sector K

Sector L

Sector M

Sector N

Sector O

Sector P

Sector Q

Sector R

Sector S

Sector U

Sector V

Sector T

Santa Ana River R.A

Temescal Wash R.A

Lower Santiago Creek R.A

Upper Santiago Creek R.A

Mayhew Goldwater Fon R.A

Arroyo Trabuco R.A

San Juan Creek R.A

Quarry

Quarry

Temescal Wash R.A.

ARROYO TRABUCO

APPROXIMATE BOUNDARY OF AREA SERVED BY SAN JUAN CREEK RESOURCE AREAS

Scale 1:250,000

5 0 5 10 15 Statute Miles

5 0 5 10 15 20 Kilometers

# GENERALIZED MAP SHOWING RESOURCE AREAS IN THE ORANGE COUNTY - TEMESCAL VALLEY AND ADJACENT P-C REGIONS AND RESOURCE SECTORS IN THE ORANGE COUNTY - TEMESCAL VALLEY P-C REGION

Topographic base by U.S.Geological Survey

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